SSM17C

Integrated Step-Servo Motor

User Manual

Rev. 1.0

AMP & MOONS' Automation

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Model	Communications	
	RS-232	CANopen
SSM17C-1CG	✓	✓
SSM17C-2CG	✓	✓
SSM17C-3CG	✓	✓

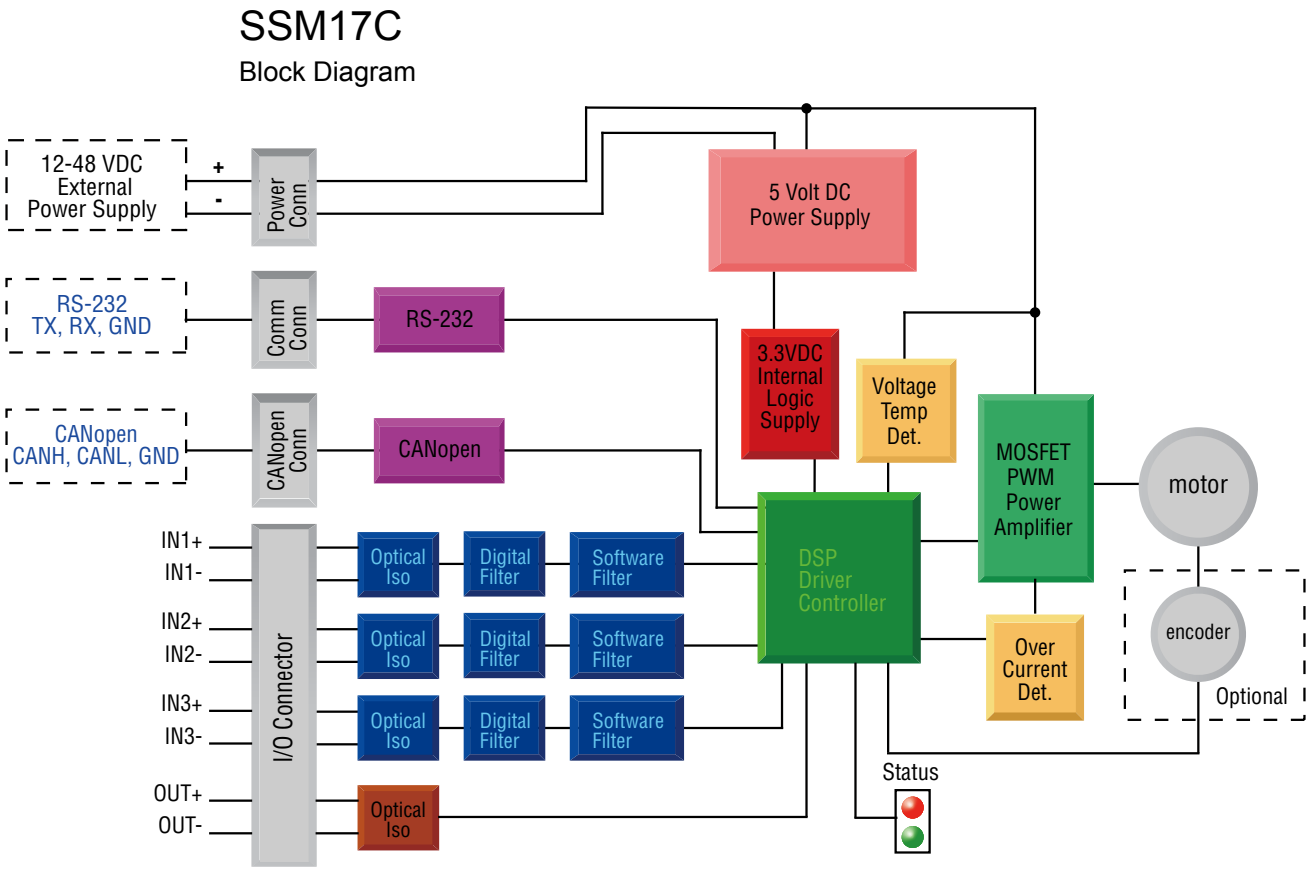
1 Introduction

Thank you for selecting the MOONS' SSM17C Integrated Motor.The SSM line of integrated step-servo motors combines servo technology with an integrated motor to create a product with exceptional feature and broad capability. We hope our commitment to performance, quality and economy will result in a successful motion control project.

1.1 Features

- Programmable, Digital servo driver and motor in an integrated package
- Operates from a 12 to 48 volts DC power supply
- Modes of Operation:
  - CANopen(complant CiA DSP402)
    - Profile Torque
    - Profile Velocity
    - Profile Position
    - Homing
  - Q Programing
    - Execute stored Q programs via MOONS' specific CANopen objects
- Communications:
  - CANopen & RS-232
- 5000 line (20,000 counts/rev) encoder feedback
- Available torque:
  - SSM17C-1CG: Up to 0.28N•m Continuous(0.35 N•m Boost)
  - SSM17C-2CG: Up to 0.42N•m Continuous(0.52 N•m Boost)
  - SSM17C-3CG: Up to 0.52N•m Continuous(0.68 N•m Boost)
- I/O:
  - 3 optically isolated digital inputs, with adjustable bandwidth digital noise rejection filter, 5 to 24 volts
  - 1 optically isolated digital output, 30V/100 mA max.
- Technological advances:
  - Full servo control, Closed loop
  - Efficient, Accurate, Fast, Smooth
  - Intelligent, Compact

1.2 Block Diagram



I/O Configurations

IN1 (5 to 24 Volts)	IN2 (5 to 24 Volts)	IN3 (5 to 24 Volts)	OUT (30V, 100mA)
: CW Limit : General Purpose	: CCW Limit : General Purpose	: Enable Input : Reset Input : General Purpose	: Brake Output : Alarm Output : Motion Output : General Purpose : In Position

1.3 Safety Instructions

Only qualified personnel should transport, assemble, install, operate, or maintain this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, operation, and maintenance of motors, and who meet the appropriate qualifications for their jobs.

To minimize the risk of potential safety problems, all applicable local and national codes regulating the installation and operation of equipment should be followed. These codes may vary from area to area and it is the responsibility of the operating personnel to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. MOONS' does not guarantee the products described in this publication are suitable for a particular application, nor do they assume any responsibility for product design, installation, or operation.

- Read all available documentation before assembly and operation. Incorrect handling of the products referenced in this manual can result in injury and damage to persons and machinery. All technical information concerning the installation requirements must be strictly adhered to.

- It is vital to ensure that all system components are connected to earth ground. Electrical safety is impossible without a low-resistance earth connection.

- This product contains electrostatically sensitive components that can be damaged by incorrect handling. Follow qualified anti-static procedures before touching the product.

- During operation keep all covers and cabinet doors shut to avoid any hazards that could possibly cause severe damage to the product or personal health.

- During operation, the product may have components that are live or have hot surfaces.

- Never plug in or unplug the Integrated Motor while the system is live. The possibility of electric arcing can cause damage.

Be alert to the potential for personal injury. Follow recommended precautions and safe operating practices emphasized with alert symbols. Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. The purpose of this section is to alert users to the possible safety hazards associated with this equipment and the precautions necessary to reduce the risk of personal injury and damage to equipment. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

2 Getting Started

The following items are needed:

- a 12 - 48 volt DC power supply, see the section below entitled “Choosing a Power Supply” for help in choosing the right one
- a small flat blade screwdriver for tightening the connectors (included)
- a PC running Microsoft Windows 2000, XP, Vista, or Windows 7
- the MOONS’ CD (included)
- a MOONS’ RS-232 programming cable (included)

2.1 Installing Software

Before utilizing the SSM17C Integrated Step-Servo Motor and SSM Quick Tuner Software in an application, the following steps are necessary:

- Install the SSM Quick Tuner software from the CD, software is also available at MOONS’ website.
- Connect the drive to the PC using the RS-232 programming cable.
- Connect the drive to the power supply. See instructions below.
- Launch the software by clicking Start...Programs...MOONS’.
- Apply power to the drive.
- The software will recognize the drive and display the model and firmware version. At this point, it is ready for use.

2.2 Mounting the Hardware

As with any step motor, the SSM17C must be mounted so as to provide maximum heat sinking and airflow. Keep enough space around the Integrated Motor to allow for airflow.

- Never use the drive where there is no airflow or where other devices cause the surrounding air to be more than 40°C (104°F).
- Never put the drive where it can get wet.
- Never use the drive where metal or other electrically conductive particles can infiltrate the drive.
- Always provide airflow around the drive.

2.3 Choosing a Power Supply

The main considerations when choosing a power supply are the voltage and current requirements for the application.

2.3.1 Voltage

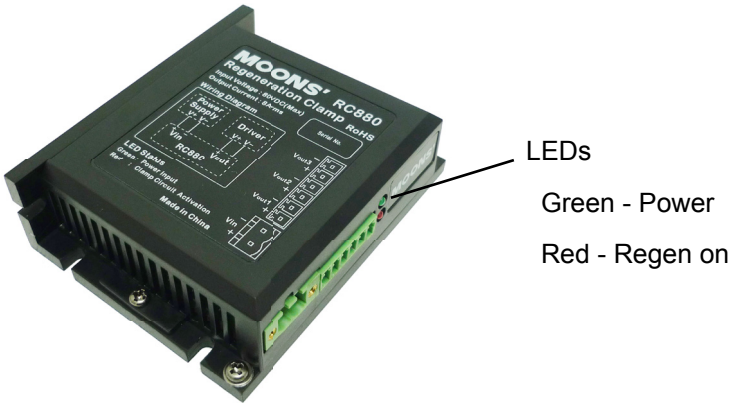
The SSM17C is designed to give optimum performance between 24 and 48 Volts DC. Choosing the voltage depends on the performance needed and motor/drive heating that is acceptable and/or does not cause a drive over-temperature. Higher voltages will give higher speed performance but will cause the SSM17C to produce higher temperatures. Using power supplies with voltage outputs that are near the drive maximum may significantly reduce the operational duty-cycle.

The extended range of operation can be as low as 10 VDC minimum to as high as 55 VDC maximum. When operating below 18 VDC, the power supply input may require larger capacitance to prevent under-voltage and internal-supply alarms. Current spikes may make supply readings erratic. The supply input cannot go below 10 VDC for reliable operation. Absolute minimum power supply input is 10 VDC. If the Input supply drops below 10 VDC the low voltage alarm will be triggered. This will not fault the drive.

Absolute maximum power supply input is 55 VDC at which point an over-voltage alarm and fault will occur. When using a power supply that is regulated and is near the drive maximum voltage of 55 VDC, a voltage clamp may be required to prevent over-voltage when regeneration occurs. When using an unregulated power supply, make sure the no-load voltage of the supply does not exceed the drive's maximum input voltage of 55 VDC.

2.3.2 Regeneration Clamp

If a regulated power supply is being used, there may be a problem with regeneration. When a load decelerates rapidly from a high speed, some of the kinetic energy of the load is transferred back to the power supply, possibly tripping the over-voltage protection of a regulated power supply, causing it to shut down. This problem can be solved with the use of a MOONS' RC880 Regeneration Clamp. It is recommended that an RC880 initially be installed in an application. If the "regen" LED on the RC880 never flashes, the clamp is not necessary.

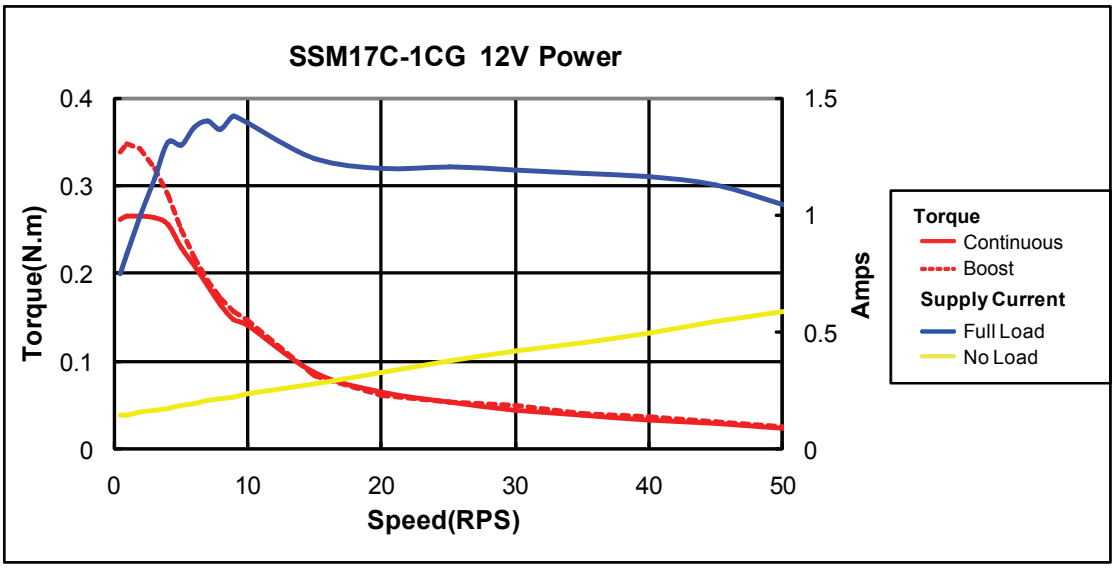


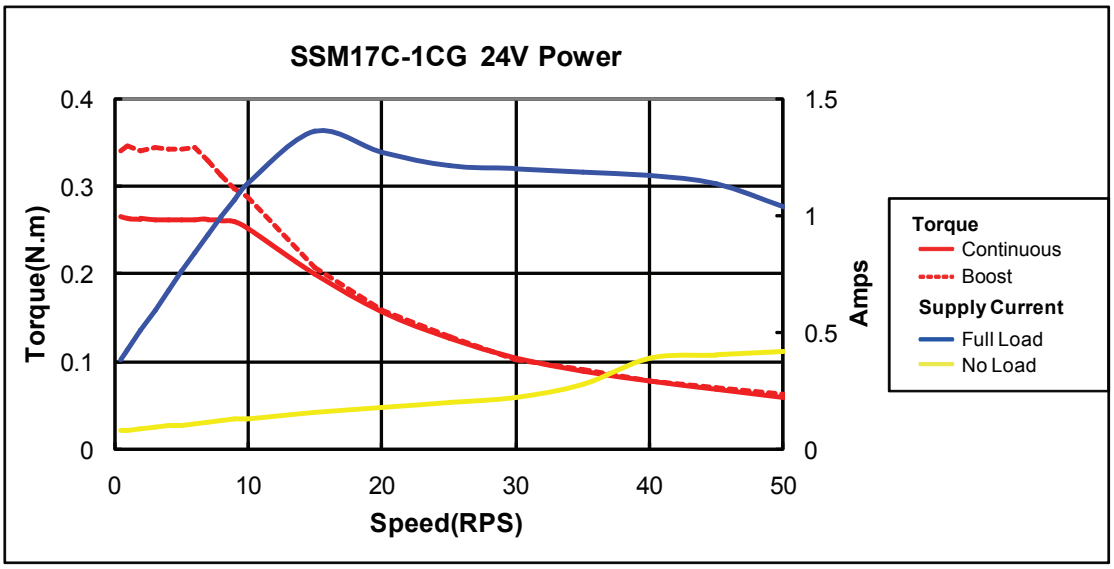
RC880 Regen Clamp

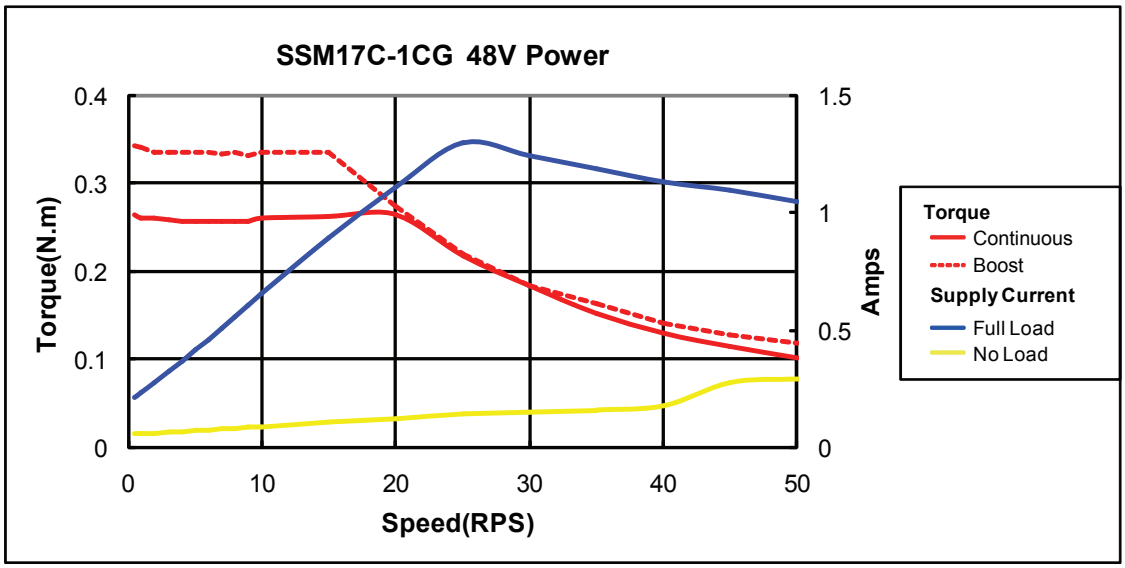
2.3.3 Current

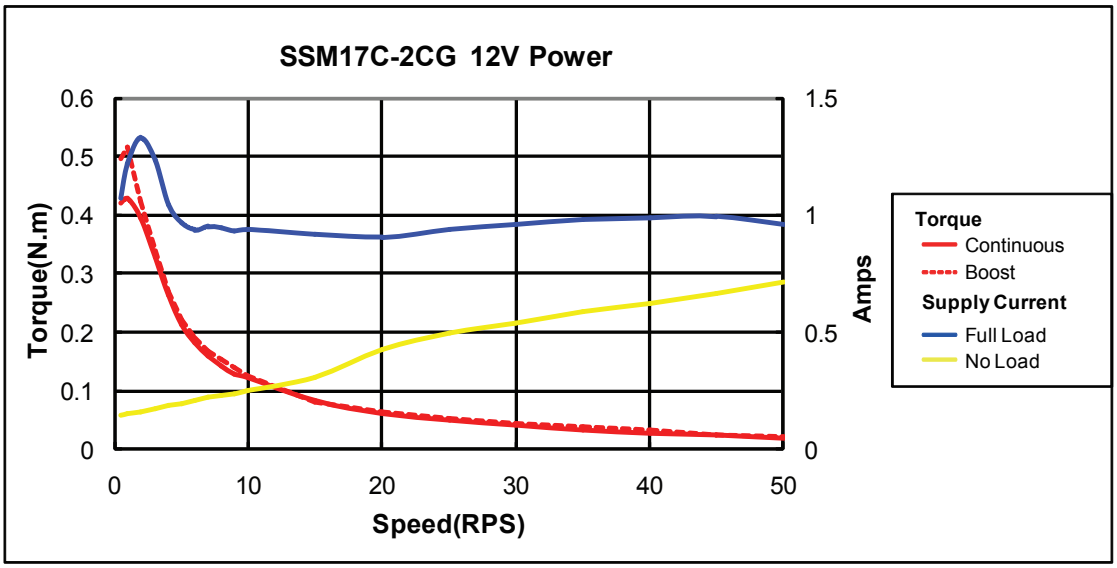
The maximum supply currents required by the SSM17C are shown in the charts below at different power supply voltage inputs. The SSM17C power supply current is lower than the winding currents because it uses switching amplifiers to convert a high voltage and low current into lower voltage and higher current. The more the power supply voltage exceeds the motor voltage, the less current will be required from the power supply.

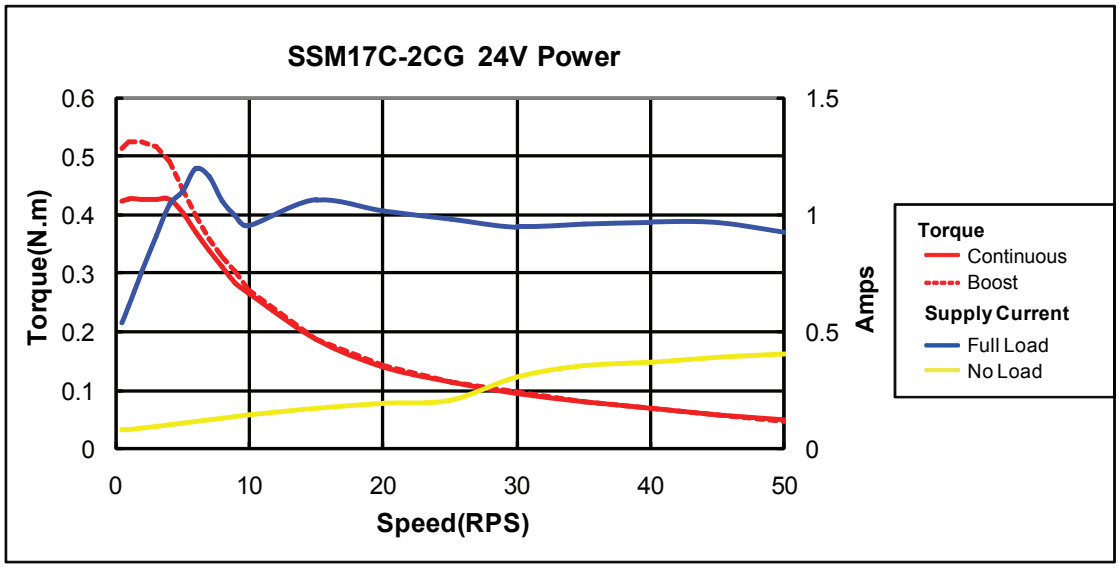
It is important to note that the current draw is significantly different at higher speeds depending on the torque load to the motor. Estimating how much current is necessary may require a good analysis of the load the motor will encounter.

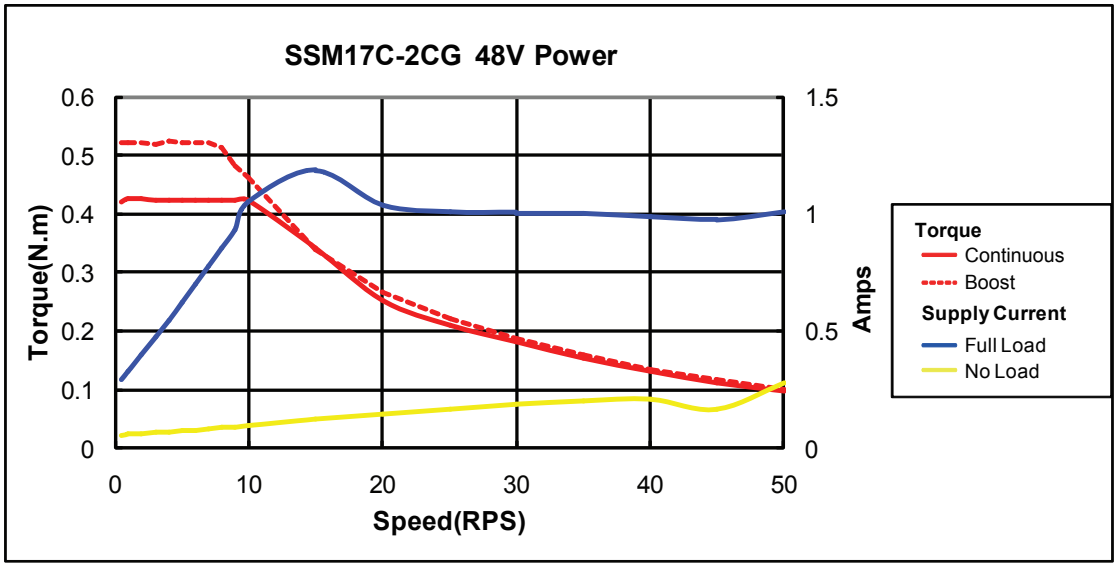


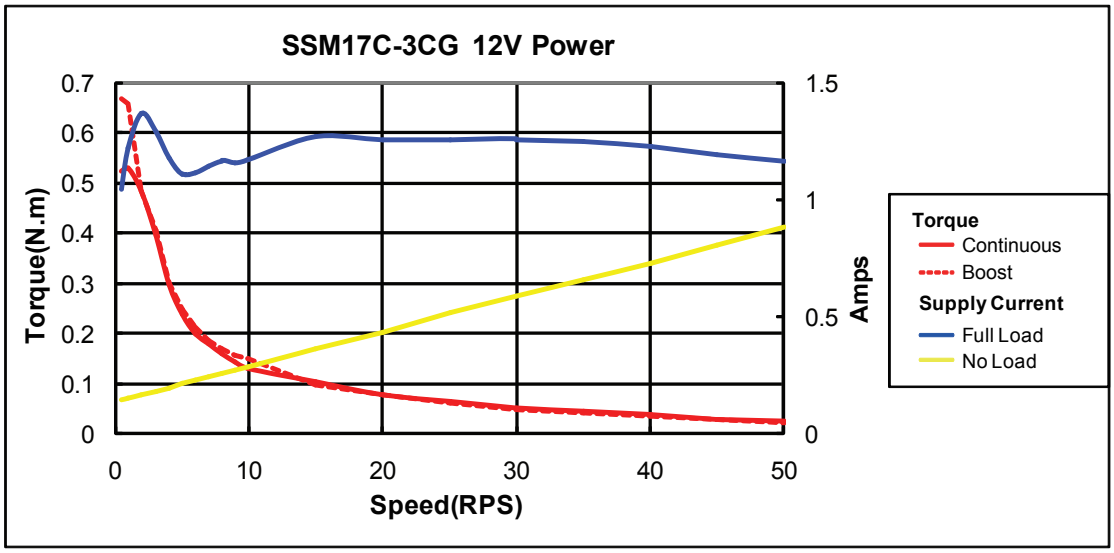


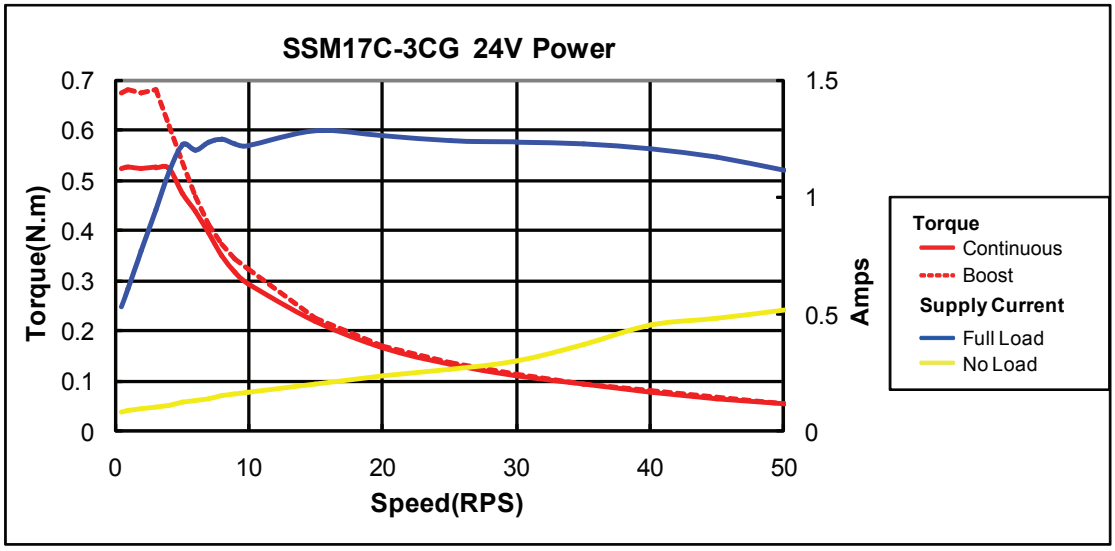

SSM17C-1CG 48V Power
Torque(N.m)
0.4
0.3
0.2
0.1
0
Amps
1.5
1
0.5
0
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load

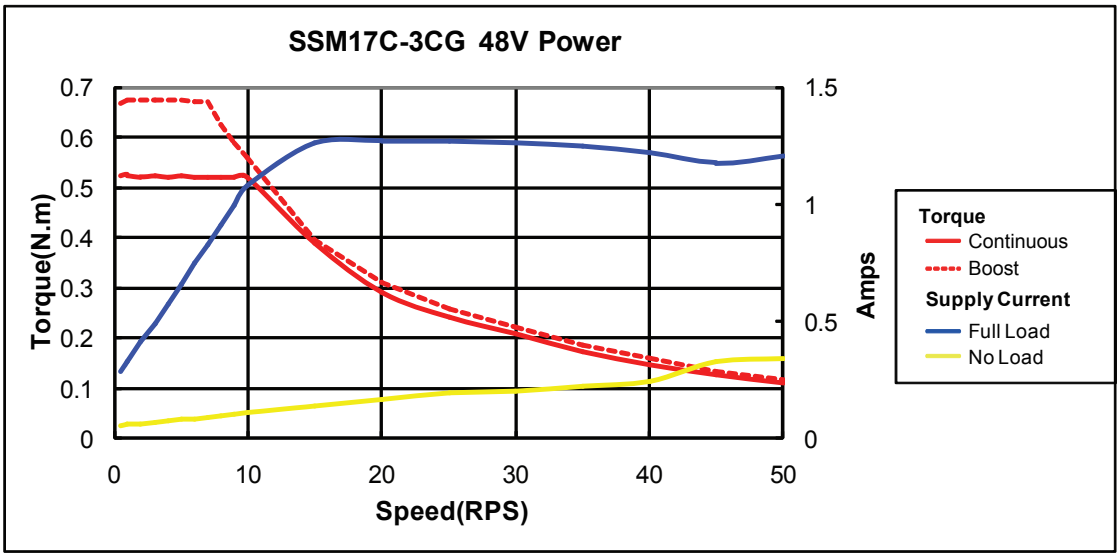

SSM17C-2CG 12V Power
Torque(N.m)
0.6
0.5
0.4
0.3
0.2
0.1
0
Amps
1.5
1
0.5
0
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


SSM17C-2CG 24V Power
Torque(N.m)
0.6
0.5
0.4
0.3
0.2
0.1
0
Amps
1.5
1
0.5
0
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


SSM17C-2CG 48V Power
Torque(N.m)
0.6
0.5
0.4
0.3
0.2
0.1
0
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


SSM17C-3CG 12V Power
Torque(N.m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load


SSM17C-3CG 24V Power
Torque(N.m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.5
1
0.5
0
Amps
0
10
20
30
40
50
Speed(RPS)
Torque
Continuous
Boost
Supply Current
Full Load
No Load

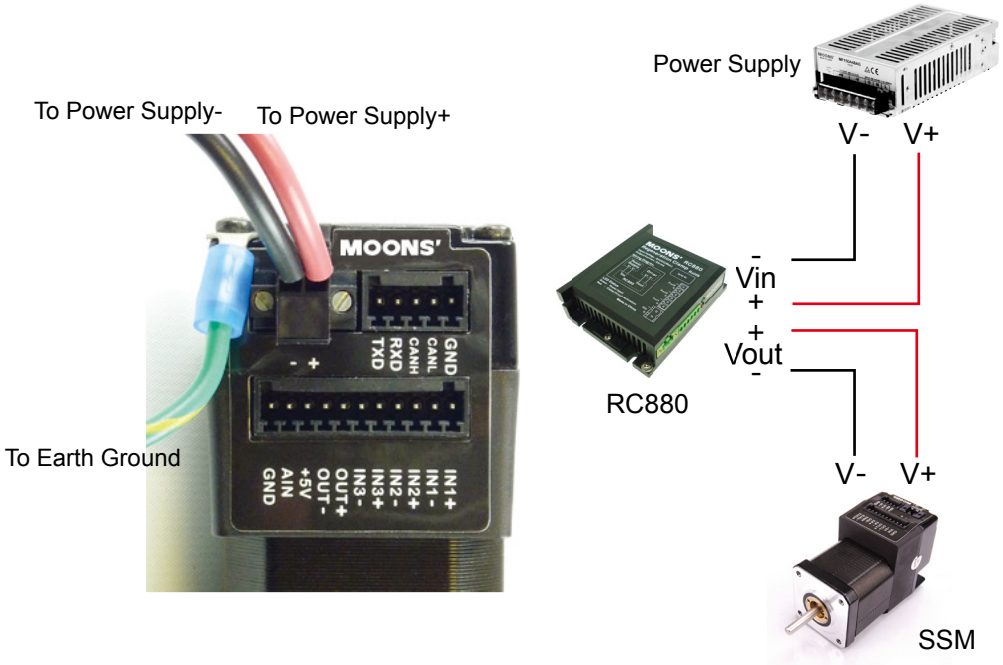

SSM17C-3CG 48V Power
Torque(N.m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
Speed(RPS)
1.5
1
0.5
0
Amps
Torque
Continuous
Boost
Supply Current
Full Load
No Load

3 Installation/Connections

3.1 Connecting the Power Supply

Use 16 to 20-gauge wire to connect the SSM17 to a power supply. It contains an internal fuse connected to the “+” terminal that is not user replaceable. If a user serviceable fuse is desired, install a 4 amp fast acting fuse in line with the “+” power supply lead.

Be careful not to reverse the wires. Reversing the connection may open the internal fuse on the drive and void the warranty.

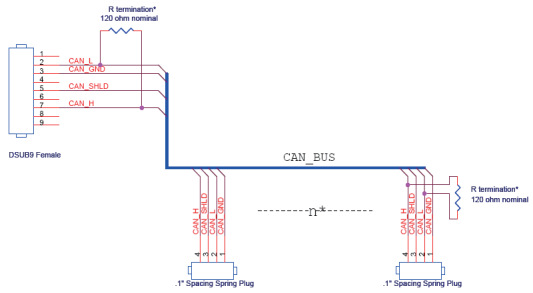


MOONS' offers two matched power supplies for use with the SSM.
A 24VDC, 150W(P/N MF150A24AG-V) and a 48VDC 320W(P/N MF320A48AG-V).
These power supplies have current over load capability making them ideal for use.
(To use with a switch power supplier, a RC880 regen must be connected in system)

The RC880 regeneration clamp is for use where regeneration from the motor may cause damage to the drive. In these cases the RC880 is connected between the drive and power supply and absorbs regenerated energy.

3.2 Connecting the SSM17C Communications

The communications interface for the SSM17C is two standard 3-pin spring clamp connectors. A special cable designed to work with the serial port for configuration is included. The SSM17C is configured using a combination of rotary switches and an RS-232 serial link, and then may be deployed on a distributed CANopen network. The RS-232 interface is used for configuration, tuning, node ID setting and Q program downloading. The CANopen network should be connected in a daisy-chain fashion, with a 120 ohm terminating resistor at each end of network.



R termination:
Network must be terminated at each end with a 120 ohm resistor.

n:
Cable may be made with up to 127 drive connectors. Termination is only required at each end.

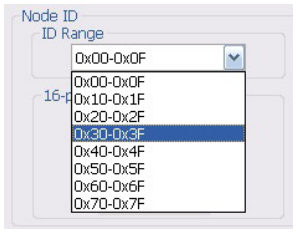
Locate the SSM17C within 2.5 meters of the PC. Plug the DB9 connector of the communication cable that came with the drive into the serial port of the PC. Plug the 3-pin spring clamp connector into the appropriate connector on the SSM17C. Secure the cable to the PC with the screws on the DB9 connector.

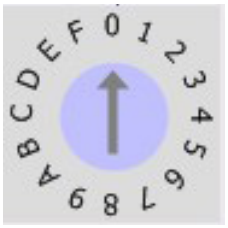
Note: If the PC does not have an RS-232 serial port, a USB Serial Converter will be needed. You can contact MOONS' to buy a USB to RS-232 converter.

The RS-232 circuitry does not have any extra electrical "hardening" and care should be taken when connecting to the RS-232 port as hot plugging could result in circuit failure.

3.2.1 Node ID

Each node ID on a CANopen network must have a unique Node ID. The Node ID is configured using a sixteen position switch to set the lower four bits of the Node ID while the upper three bits are configured by using ST Configurator. CANopen Node IDs are seven bits long, with a range of 1 - 127, or 0x01 - 0x7F in hexadecimal notation. Node ID 0x00 is reserved in accordance with the DS301 specification.





3.2.2 Setting the Bitrate

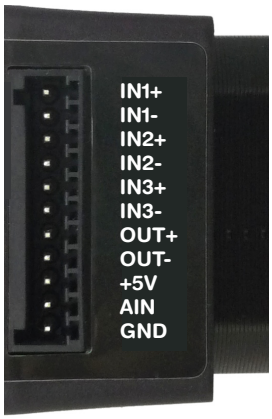
The CANopen network bitrate is set by the ten position switch on the front of the drive. The bit rate must be the same for all nodes on the CANopen network. Any changes to the bit rate require either a power cycle or a CANopen reset command to take effect.

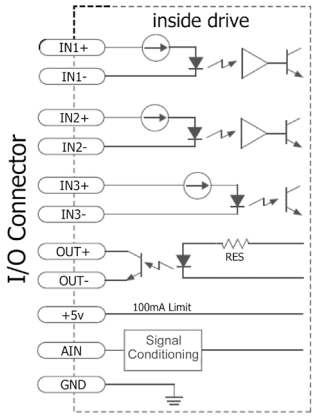
SW1	Bit Rate
0	1 Mbps
1	800 kbps
2	500 kbps
3	250 kbps
4	125 kbps
5	50 kbps
6	20 kbps
7	12.5 kbps
8	reserved
9	reserved

3.3 Inputs and Outputs

The SSM17C has three optically isolated inputs that use 5 to 24V volts logict

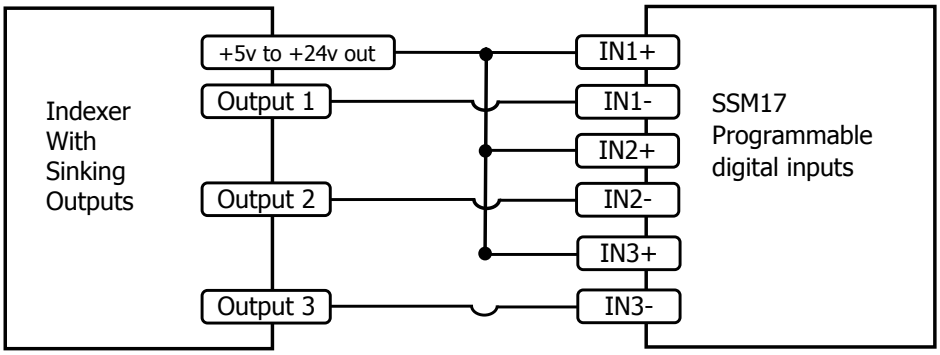
3.3.1 Connector Pin Diagram



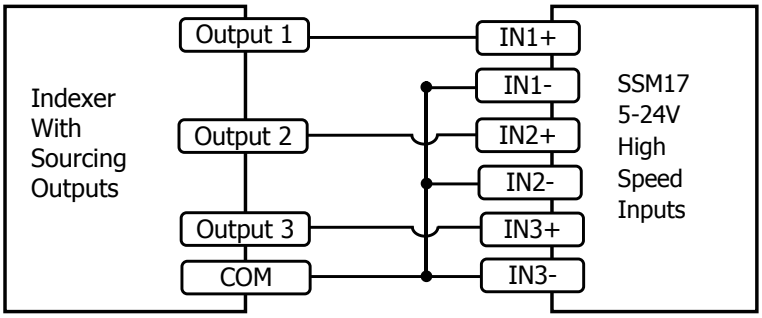


3.3.2 IN1 & IN2 Inputs

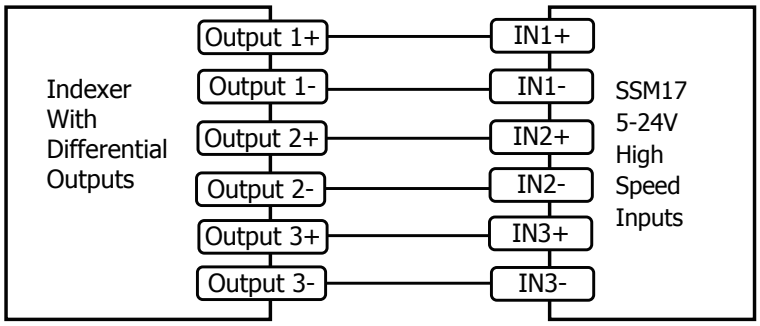
IN1 and IN2 digital inputs are designed for high speed digital input operation between 5 and 24 volts. The diagrams below show how to connect them to various commonly used devices like sensors, switches, relays, PLCs, etc.



Connecting to Indexer with Sinking Outputs



Connecting to Indexer with Sourcing Outputs

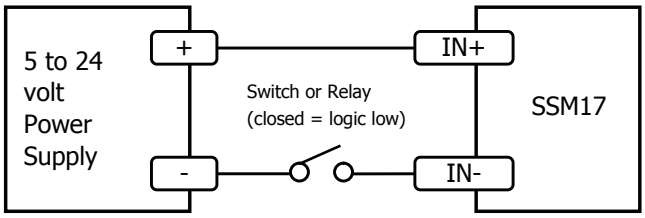


Connecting to Indexer with Differential Outputs
(Many high speed indexers have differential outputs)

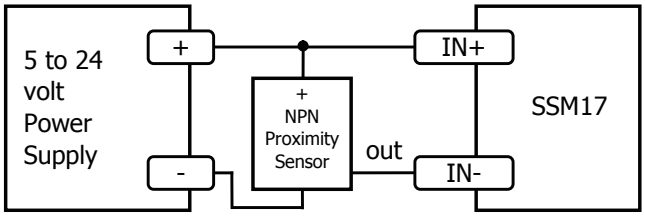
Note: If current is flowing into or out of an input, the logic state of that input is low or closed. If no current is flowing, or the input is not connected, the logic state is high or open.

3.3.3 IN3 Input

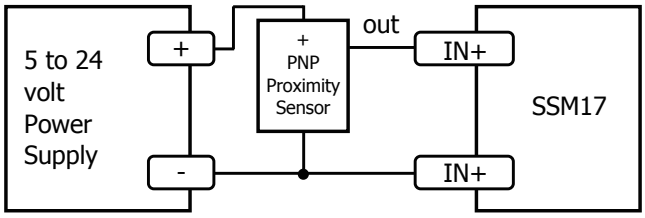
The IN3 digital input is designed for low speed digital input operation between 5 and 24 volts. The diagrams below show how to connect them to various commonly used devices like sensors, switches, relays, PLCs, etc.



Connecting the Input to a Switch or Relay



Connecting an NPN type Proximity Sensor to an input
(when prox sensor activates, input goes low)



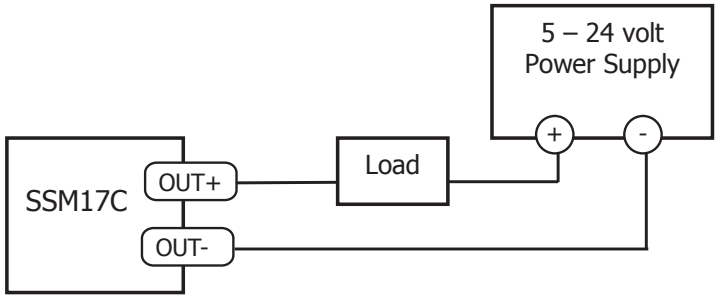
Connecting an PNP type Proximity Sensor to an input
(when prox sensor activates, input goes low)

Note: If current is flowing into or out of an input, the logic state of that input is low or closed. If no current is flowing, or the input is not connected, the logic state is high or open.

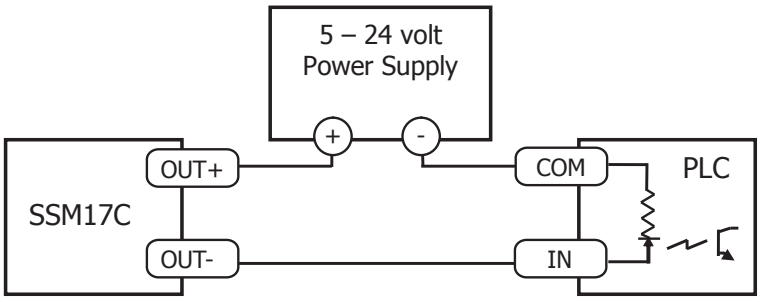
3.3.4 Programmable Output

The SSM17C drives feature one optically isolated digital output (OUT). This output can be set to automatically control a motor brake, to signal a fault condition, to indicate when the motor is moving or to provide an output frequency proportional to motor speed (tach signal). Or the output can be turned on and off by program instructions like Set Output (SO). The output can be used to drive LEDs, relays and the inputs of other electronic devices like PLCs and counters. The OUT+ (collector) and OUT- (emitter) terminals of the transistor are available at the connector. This allows the output to be configured for current sourcing or sinking.

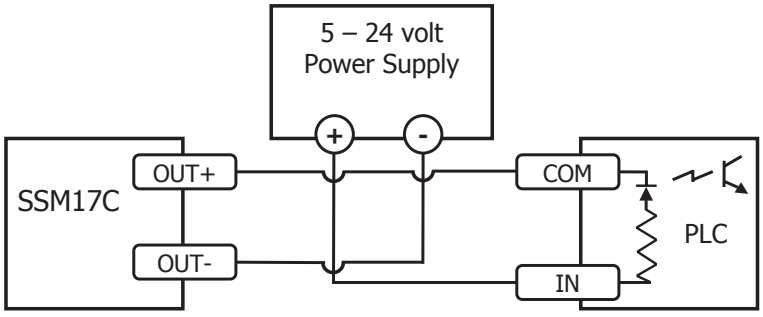
Diagrams of various connection types follow.



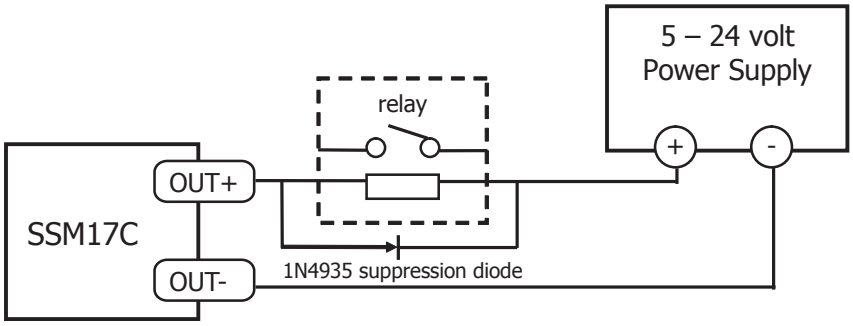
Connecting a Sinking Output



Connecting a Sourcing Output



Connecting a Sourcing Output again

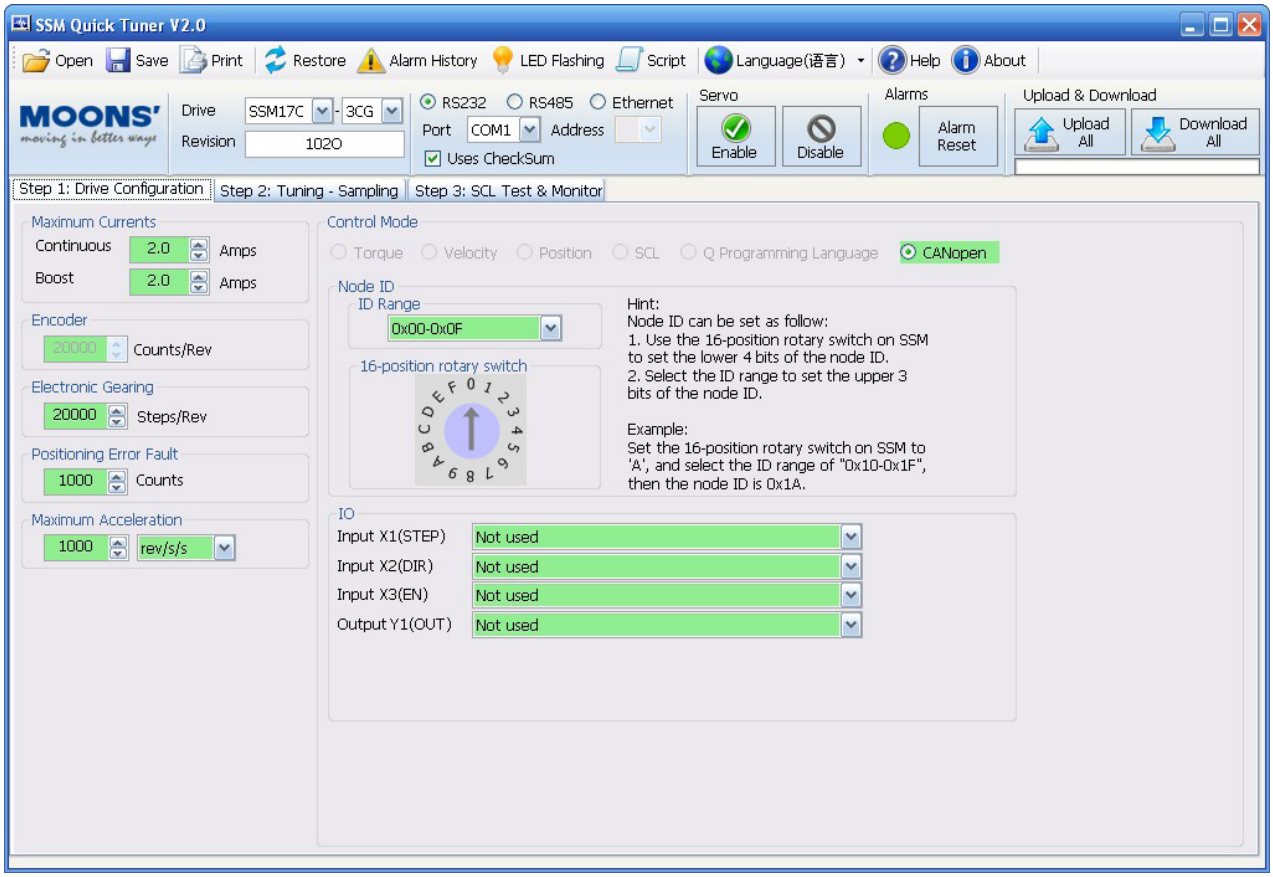


Driving a Relay

Do not connect the output to more than 30 volts. The current through the output terminal must not exceed 100mA.

4 Drive Configuration

SSM Quick Tuner is the PC based software application used to configure, and perform servo tuning, drive testing and evaluation of the SSM. System servo control gains, drive functionality, and I/O configuration are set with Quick Tuner. It also contains an oscilloscope function to help set the servo control gains.



4.1 Quick Tuner Toolbar

4.1.1 Open, Save, and Print

In addition to exchanging settings with a drive, the SSM Quick Tuner software can also save & load settings using the PC's hard drive.

The **Open** button brings up a dialog box showing all the SSM Quick Tuner files on the hard drive.

When a large number of identical machines are being built it is useful to be able to exactly duplicate each set-up. When development of one machine is completed and the motion control is working correctly, it can be saved to a file. When the next machine is built, the set-up file may be opened and downloaded to that drive. One of the advantages of programmable, digital control is this easy duplication of system settings.

With the **Save** button a set-up can be saved to the hard drive. Long file names may be used just as with other 32 bit Windows programs, such as Microsoft Word or Excel.

The **Print** button allows a hard copy of a program to be printed on any system printer. The standard Windows printer dialog is used, allowing the choice of typical printer settings.

4.1.2 Restore

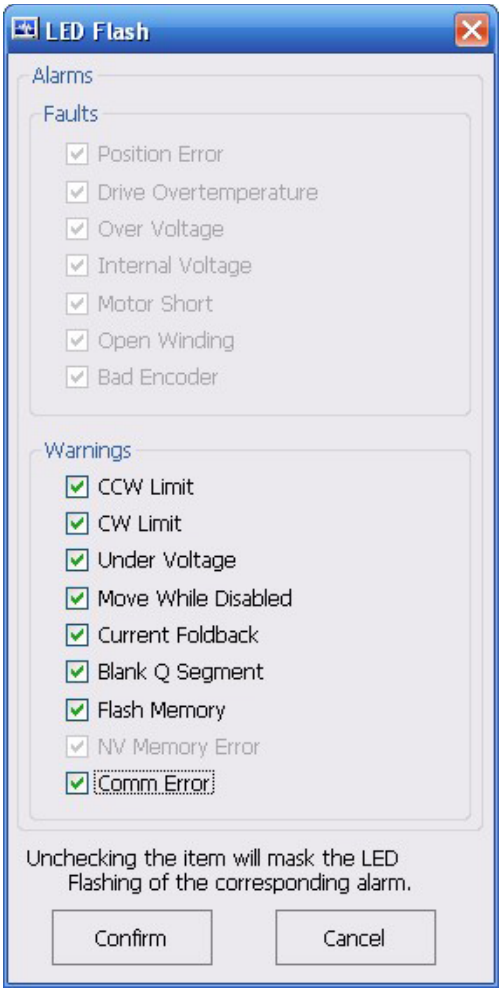
The **Restore** button will reset all parameters in the drive to the ones set by the factory (defaults). Note - as this will erase all parameters that have been changed, it may be desired to save them to a file first.

4.1.3 Alarm History

The SSM stores a log of previous alarm conditions viewable in the **Alarm History**. When an alarm occurs, the drive stores the information on which alarm conditions were triggered. As a fault may trigger more than one alarm condition, the drive stores all of them for reference. This information can then be viewed in the Alarm History dialog to help with drive and system problem solving. The drive stores up to 8 sets of alarm conditions. The Alarm History dialog can also be used to clear the Alarm History.

4.1.4 LED Flashing

Clicking on this button will bring up a screen where the LED flashing for certain warnings can be masked. Alarm fault conditions are not allowed to be masked and will always be indicated by the drive's LEDs. Masking alarm warnings only prevents the indication of the alarm by the LEDs. The alarm warning will still be set in the Alarm status code and in the Alarm History. See section 7 on "Troubleshooting" below for an explanation of these codes.



4.1.5 Drive & Revision

When SSM Quick Tuner is connected to an SSM Integrated Motor the drive model, sub-model, and firmware revision are automatically indicated. If working offline (no drive is connected), the Drive model and sub-model can be selected from the drop down lists. The model and sub-model information is found on the label of the SSM integrated motor.

4.1.6 Communication

When the SSM Quick Tuner is connected to an SSM Integrated Motor the drive model and sub-model will cause the communications to be set to RS-232. If SSM Quick Tuner is unable to connect to the SSM Integrated Motor, manually selecting the communications type may help establish the connection.

Port

The correct COM port may need to be selected. When the software is loaded, it looks for the first available COM port, but may not always find the one connected to the drive. After a specific COM port has been selected this setting is saved when the SSM Quick Tuner is closed. If the saved COM port is available next time Quick Tuner is started it will be automatically selected

Select the port from the drop-down list. If the port exists and is not already in use, the software will use it to communicate with the SSM.

Uses Check Sum

The SSM Integrated Motor supports using a check sum in the communication protocol. For more reliable communications this option can be selected. Checksum is used automatically when the SSM is being configured, tuned or operated in the target environment. This can prevent mis-information being sent to or received back from the drive.

4.1.7 Servo Enable/Disable

The **Enable** button energizes the motor and tells it to be ready to accept motion commands. The **Disable** button cuts the current to the motor and it will not be able to execute motion commands.

The Enable button must be used to re-enable motor operation after a fault condition has occured. Before the enable can be used the alarm fault condition must be cleared. See Alarm Reset below.

4.1.8 Alarms

Indicator

When a fault occurs the Alarm indicator will flash red, a warning will trigger a flashing orange signal. Green indicates there is no alarm condition.

Alarm Reset

The **Alarm Reset** button will clear the alarm and return the signal to green if the alarm condition can be cleared. In some cases an alarm condition can be persistent and other action may be required to remedy the condition.

4.1.9 Upload & Download

The **Upload** button allows the complete set up and tuning parameters from an SSM to be copied to Quick Tuner. Later these settings can be saved to a PC file (see “File Saving” above). It is very important to perform an upload from a configured drive so that its configuration is not accidentally over-written.

The **Download** button is used to copy settings from Quick Tuner to the drive. Each time the download button is clicked, all configuration settings will be downloaded to the drive.

4.2 Basic Configuration

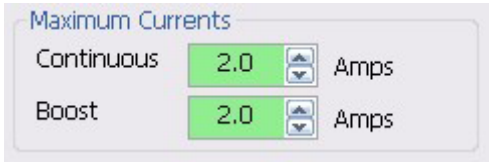
The default control modes for the SSM17C integrated step servo is SCL mode.

There are total 5 sets of parameters, 4 of them need to be configured.

4.2.1 Maximum Currents

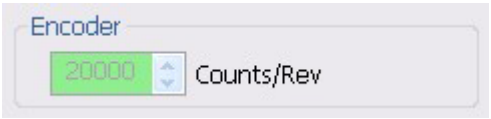
Continuous - The current that can be sustained indefinitely.

Boost - An SSM drive can provide a momentary current boost. This allows for greater acceleration rates than would otherwise be possible. To assure reliable motor operation, the drive automatically ramps the current down after one second so that the average current does not exceed the motor's rating.



4.2.2 Encoder

Encoder resolution is fixed at 20000 counts/rev.

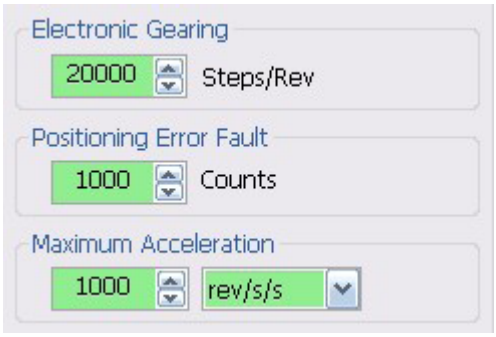


4.2.3 Electronic Gearing

Genarally, we recommend using the default setting 20000 steps/rev. With Electronic Gearing drive response to incoming step pulses can be adjusted. This is very useful when a step motor drive is being replaced with a step-servo system, as the SSM can have the same number of steps/ revolution as the stepper. For example, SSM17C can be programmed to operate at 200 steps/rev, like a full step drive. If the system is working in degrees, the drive can be programmed to operate at 36,000 steps/rev resulting in an even number of steps (100) per degree.

4.2.4 Positioning Error Fault

Positioning error is the difference, in encoder counts, between the actual position and the commanded position of the motor. A small amount of positioning error is a normal part of a step-servo system. In the event of a broken wire, a failed sensor, the motor encounting a physical obstruction, or operator error, a position error fault limit can prevent damage to the system. Anytime the position error (as reported by the encoder) exceeds this set limit, the drive is disabled and a fault alarm occurs.



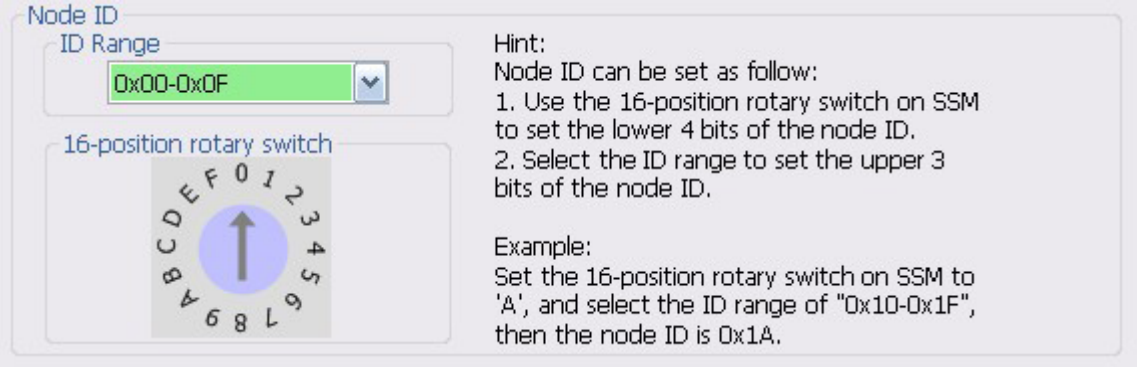
The fault limit can be set as low as 10 encoder counts, or as high as 32000. During initial tuning of the system, this value should be set high so that the drive doesn't shut down while the tuning parameters are being adjusted. Once the drive is properly tuned and the expected amount of error during normal operation is known, an appropriate fault limit can be set. For example, with QuickTuner's oscilloscope function set to plot position error, sample moves using the maximum speed and acceleration planned for use in an application should be executed. If the maximum position error is 50 counts, the fault limit could safely be set at 100.

4.2.5 Maximum Acceleration

This sets the maximum level of acceleration for the motor. Even if the command input tries to demand a higher level of acceleration, the drive will only accelerate at the set maximum level. This value is also used as a quick stop when meeting with limit sensor or other stop commands.

4.3 Node ID

Each node ID on a CANopen network must have a unique Node ID. The Node ID is configured using a sixteen position switch to set the lower four bits of the Node ID while the upper three bits are configured by using SSM Quick Tunner. CANopen Node IDs are seven bits long, with a range of 1 - 127, or 0x01 - 0x7F in hexadecimal notation. Node ID 0x00 is reserved in accordance with the DS301 specification.


Node ID
ID Range
0x00-0x0F
16-position rotary switch
Hint:
Node ID can be set as follow:
1. Use the 16-position rotary switch on SSM to set the lower 4 bits of the node ID.
2. Select the ID range to set the upper 3 bits of the node ID.
Example:
Set the 16-position rotary switch on SSM to 'A', and select the ID range of "0x10-0x1F", then the node ID is 0x1A.

4.3.1 I/O Definition

Options for **IN1** are:

- At end of travel, CW limit input will be closed
- At end of travel, CW limit input will be open
- Not used - generic programmable input

Options for **IN2** are:

- At end of travel, CCW limit input will be closed
- At end of travel, CCW limit input will be open
- Not used - generic programmable input

Options for **IN3** are:

- Not used - generic programmable input
- Enable motor when closed - the motor has no power when the input is open
- Enable motor when open - the motor has no power when the input is closed
- Reset alarm when closing - an alarm or fault can be cleared by closing the input
- Reset alarm when opening - an alarm or fault can be cleared by opening the input

Options for **Output(OUT)** are:

- Not used - generic programmable output
- Closed on fault - the output will close if a fault occurs
- Open on fault - the output will open if a fault occurs
- Closed to release brake - the output controls a fail safe brake relay
- Open to release brake - the output opens to release the brake
- Tach out - the output produces pulses relative to the motor position
- Closed when position error less than - enter a count value in the box
- Open when position error less than - enter a count value in the box

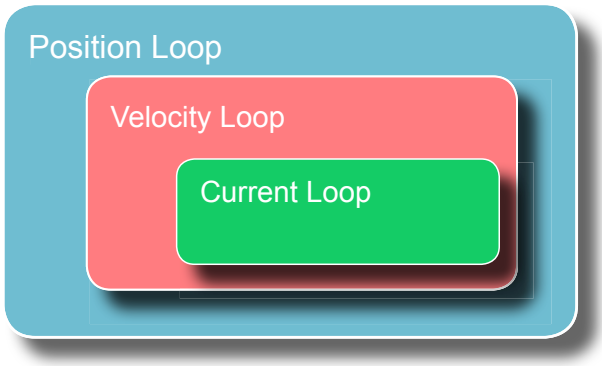
5 Tuning - Sampling

Being a servo motor, the SSM Integrated Motor employs sophisticated algorithms and electronics for controlling the torque, velocity and position of the motor to achieve a well behaved operation of the load.

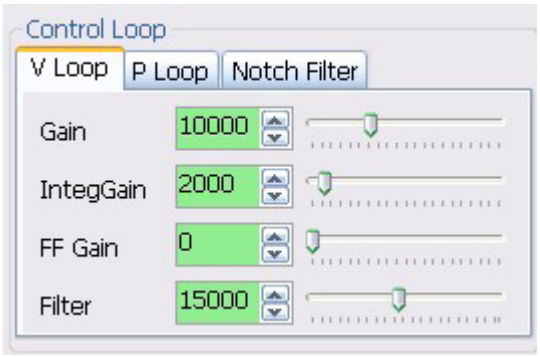
Because the motor encoder continuously tells the drive what the motor is doing, the drive can alter the current applied to the motor until the motor achieves the desired operation. This is called “closed loop control.”

One of these loops controls the amount of current going to the motor. This loop requires no adjustment other than specifying the maximum current the motor can handle without overheating.

The SSM employs two control loops for the actual motor motion. The first is a Velocity Loop which is designed to control only the speed of the motor. The second is a Position Loop that controls the count position of the motor. As shown in the drawing below, the Current Loop is contained in the Velocity Loop, and the Velocity Loop is contained in the Position Loop. Knowing this is important as good Position Loop control requires first tuning the Velocity Loop. As mentioned above, Current Loop tuning is not required as it is already optimized for the motor.



5.1 Velocity Control Loop (V Loop)



The Velocity Control Loop is designed to operate the motor in a velocity-only type of servo control. This means that it can control the speed of the motor but cannot cause the motor to follow a command position. The Jog commands available in the drive can use this loop only for operation, the advantage of this is good stability even with very high inertia loads. The JM (Jog Mode) command is available to set this feature or it can be configured when selecting the **Velocity** Control Mode. Selecting the **Speed Only** control type setting causes the Velocity Loop alone to be used in the various Jog or Velocity control functions. JM2 (Jog Mode 2) does the same. **Position over time** control type adds in the Position control loop for precise position control during the move and when stopped, JM1 (Jog Mode 1) also configures this setting.

The **Velocity Control Loop** has four terms that can be configured for optimum performance with a given load. This loop can be set and tuned independent of the Position Control Loop. These control terms are described below.

5.1.1 Gain: The Velocity Proportional Term (VP)

The simplest part of the Velocity Loop is the proportional, or VP, term. The drive applies current to the motor in direct proportion to the error. For example, if a motor is not moving, and the shaft is turned by hand or some other force, the drive will increase the motor current until the motor returns to “0” speed. The faster the motor is moved from “0” velocity, the more the opposing torque will increase. The VP term (also called VP gain) governs how much torque will be applied for a given amount of velocity error (Vn). In general, more load inertia or load friction, requires more torque and therefore a higher VP gain. The torque provided by the VP term is:

$$T = VP * Vn$$

5.1.2 IntegGain: The Velocity Integral Term (VI)

In the previous example, applying the VP term alone will not result in perfect velocity control. If one ounce-inch of torque were applied to the motor, it would move at a slower speed. The VP term will increase the motor torque until it is producing as much torque as the force attempting to move it. The motor may slow down or even stop moving but there will still be error. The VI term adds up all the error the velocity calculation has reported and produces a torque that is added to the torque command from the VP term. The equation for this is:

$$T = VP * Vn + VI\sum(V)$$

In the example, the VP term allowed the motor to reach equilibrium at a speed where the applied torque equaled the torque of the VP term. Thus, the error was not zero. But the VI term continues adding up the error and increasing the torque until the motor returns to the true target position.

5.1.3 FF Gain: Acceleration Feed-forward Term (KK)

Larger loads typically generate larger load Inertia. These larger inertias can be more easily controlled by anticipating the system’s torque need. The Acceleration Feed-forward term does this by adding an acceleration value to the Torque command. The acceleration value is derived from the Trajectory Calculation during the acceleration and deceleration phase. As can be seen in the equation below this increased Torque command is added with the VP and VI torque command values:

$$T = KK * A + VP * Vn + VI\sum(V)$$

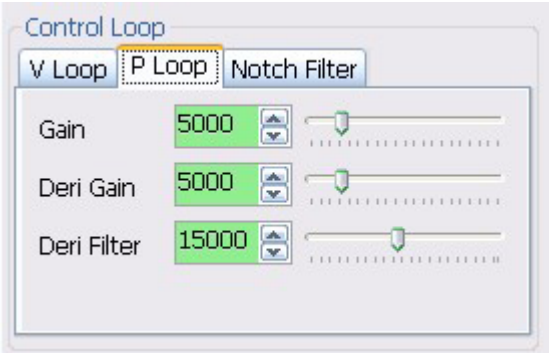
5.1.4 PID Filter: Torque Command Filter Term (KC)

This final term in the Velocity control loop can be considered an over-all filter term. In fact this term is always used even when the drive has been placed in the Torque Control Mode where only the Current control loop is active. The filter is a very simple single-pole low pass filter that is used to limit the high frequency response of the Velocity and therefore the Position control loops.

5.2 Position Control Loop

The **Position Control Loop** is designed to provide the typical positioning control for a servo system. All positioning type operations use this loop including when operating in the **Pulse & Direction Position Control Mode**. The Position loop can also be used in the **Velocity Control Mode** when the **Position over time** control type option is selection or the Jog Mode is JM=1.

The Position Control Loop has three terms that can be configured for optimum performance with the given load. These control terms are described below:



5.2.1 Gain: The Position Proportional Term (KP)

The simplest part of the Position loop is the proportional, or KP, term. The drive applies current to the motor in direct proportion to the position error. For example, if a motor is not moving, and the shaft is turned by hand or some other force, the drive will increase the motor current until the motor returns to the commanded target position (rest position). The farther the motor is moved from its target position, the more the torque will increase. The KP term (also called KP gain) governs how much torque will be applied for a given amount of error (Un). In general, more load inertia or load friction, requires more torque and therefore a higher KP gain.

Because of the topology of the control loops, the Position Control Loop output is actually a velocity command that indirectly affects the Torque command to the motor. The Velocity command provided by the P term is:

$$V = VP * Un$$

5.2.2 The Position Integral Term (KI) - Not Implemented

There is no KI term as it is not required because of the Velocity loop which contains an Integrator term. Any position error will taken up and corrected for in the Velocity loop.

5.2.3 Deri Gain: The Derivative Term (KD)

A motor run with a pure PI controller would overreact to small errors, creating even larger errors and becoming unstable. By predicting what a motor will do ahead of time, the large errors and instability can be avoided. The derivative term determines this by analyzing the rate of change of the position error and including that in the torque calculation. For example, if the motor has a position error, but the rate of change of the error is decreasing, torque is lowered. The formula used here is:

$$V = KP * Un + KD * (Un – (Un-1))$$

where:

Un is the error in encoder counts

Un-1 is the error of the previous sample

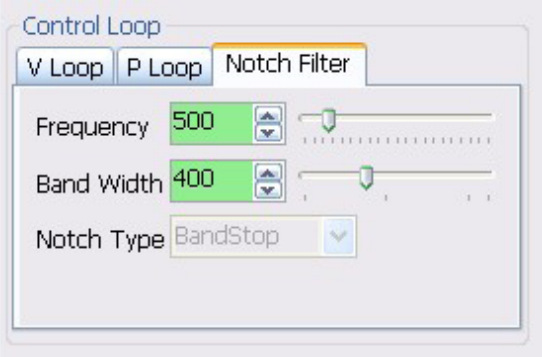
5.2.4 Deri Filter: Torque Command Filter Term (KE)

A derivative control term can be rather noisy and even though it is effective in damping the positioning control, it can cause objectionable audible or observable noise to the system. The filter is a very simple single-pole low pass filter that is used to limit this high frequency noise and make the system quieter and more stable.

5.3 Notch filter

For additional filtering, an over-all notch filter is added to the current command signal. This filter is similar to the PID Filter in that it is active even when the driveis being used in Torque Control Mode. Notch filters are typically used to filter at a particular frequency when there is a resonant component in the mechanical system that may oscillate at that frequency. Couplers between the motor and the load can commonly do this which may result in a control problem. When gains are increased to improve performance the system may resonate in an uncontrollable manner. The Notch Filter allows gain reduction at only the problematic resonant frequency, allowing the over-all gain to be set higher for better system control.

The notch filter has two parameters that are described below. The notch filter can only be configured though the Quick Tuner interface where the Quick Tuner software calculates the filter constants used by the drive.

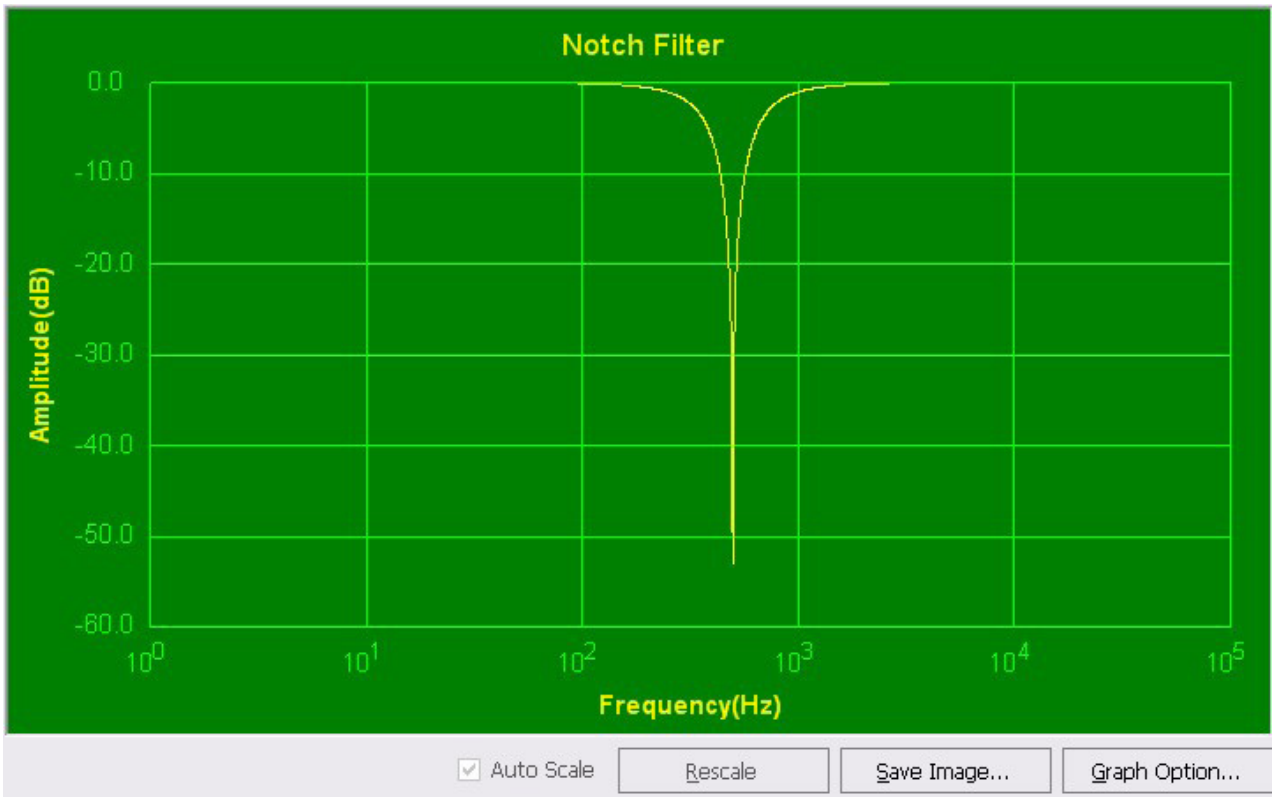


5.3.1 Frequency: Notch Filter Center Frequency

This defines the center frequency - the frequency where the most gain reduction occurs. For now, finding the center frequency is a bit of a guessing game and different frequencies can be tried until the system resonance is eliminated.

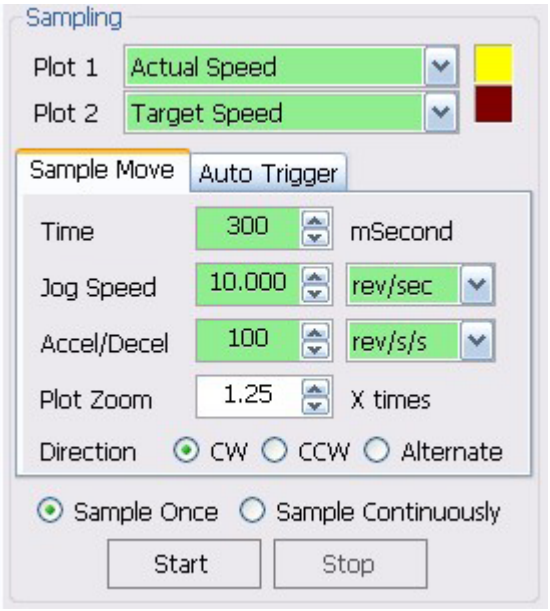
5.3.2 BandWidth: Notch Filter Frequency Bandwidth

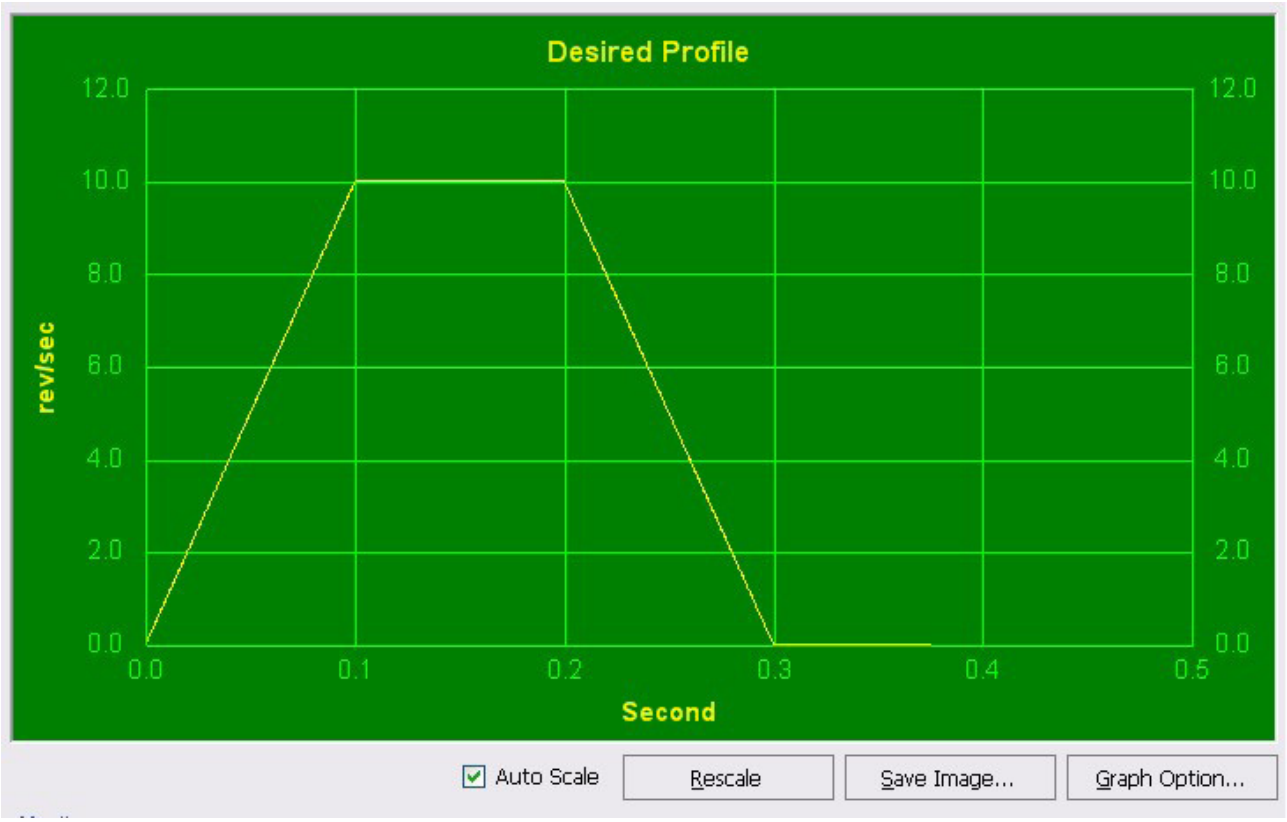
This defines the frequency span where the signal is reduced by at least 3dB. For example if the center frequency is set to 400Hz and the bandwidth to 200 the signal will be reduced by 3dB starting at 300hz. It will have the greatest reduction at 400Hz, and then will be greater than 3dB above 500Hz. When setting the notch filter a chart is displayed that provides an indication of the filtering that will be accomplished.



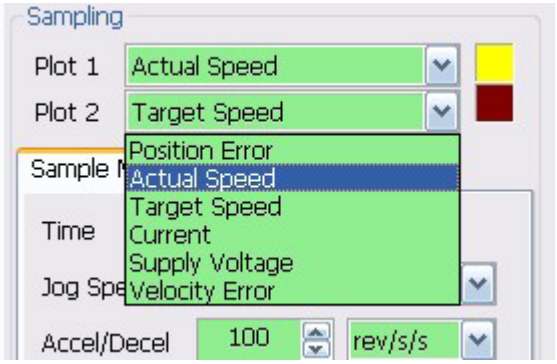
5.4 Getting Ready for Tuning

Before testing a servo-system a few more parameters need to be entered. These include the Max Speed, Acceleration and Distance (or time) requirements of the sample move. The proper profile shape of the move is needed to operate the load in the same way as what will be expected during online operation. Accelerating the load quickly may induce significant ring into the motion profile. Accelerating slower and going to a higher velocity can minimize the ringing. The best profile for a given move is sometimes arrived at more through experimentation than hard calculation. SSM QuickTuner provides easy entry of the profile parameters plus a display of the profile for verification.





The mechanical system should be set up as close to the final configuration as possible so that the tuning represents what will be expected. The critical components include the coupler, mechanical interface ,and similar frictional and inertial loads. As tuning can sometimes be an uncontrolled process where the mechanical system can be damaged, care must be taken to minimize this possibility. This could include having limit sensors or mechanical stops that help to prevent such damage.

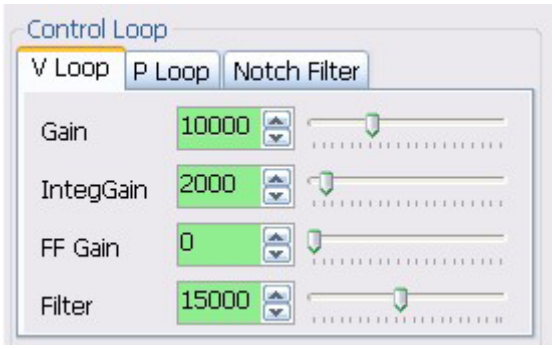


SSM Quick Tuner contains a sampling Oscilloscope that will display of variety of measurements of an executed move. Two plots can be displayed at one time and contain the real-time information about the move performance. Before performing the test move, make sure the desired move information is selected. This can include the typical information such as **Actual Speed** or **Position Error** but also can include the **Supply Voltage** so that the power supply can be monitored for proper voltage during the move.

5.5 Tuning the Velocity Loop

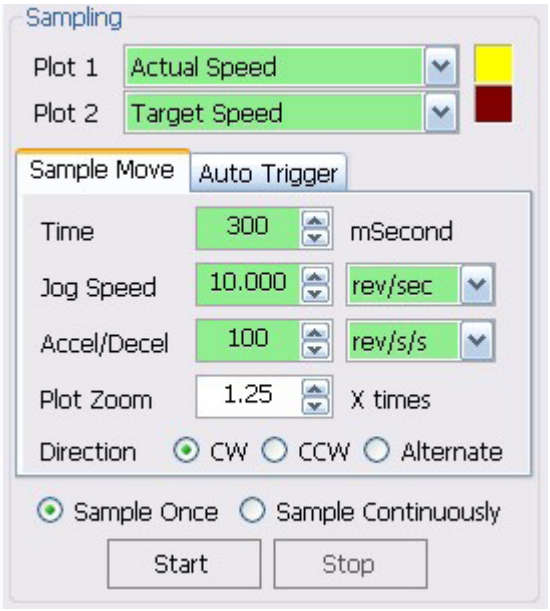
5.5.1 Entering a Sample Move

Start by selecting the **V Loop** tab in the **Control Loop** dialog section. This will cause the **Sampling** to perform moves that are based on **Time** and operates the drive in the **Speed Only** Velocity mode.



Now parameters may be entered for a **Velocity** based move.

Plot 1 & Plot 2: two different values can be selected for viewing in the scope window, in this case **Actual Speed** and **Velocity Error** are selected. These are typical values for Velocity tuning.



Sample Move: move profile values are entered in the **Sample Move** section. This example sets a move **Time** of 200ms at a **Jog Speed** of 20 rev/sec and an **Accel/Decel** rate of 300 rev/s/s. In the window to the right of the **Sampling** data entry section the **Desired Profile** will be displayed. This provides a visual reference of what the expected move will look like.

Plot Zoom: the length of the plot values that are displayed can be set from 1 to 5 times the profile length.

Dir: the direction of the move can be set to **cw**, **ccw** or **alternate**. These directions refer to the motor shaft as viewed from the front of the motor. **Alternate** toggles the direction after each move. Start with a known direction before switching to toggle.

Sample Once: after the **Start** button is clicked, a single move is performed, the motor stops, and the results will be displayed.

Sample Continuously: after the **Start** button is clicked, the move will be repeated and the results displayed until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This enables more dynamic adjustment of the gains for speeding up the tuning process.

5.5.2 Performing a Move

Once the move settings are correct the mechanism to be moved shold also be checked to ensure it is ready to move. It is especially important to make sure the direction is set correctly. In some cases it is wise to select **alternate** to avoid running the mechanism into a hard stop. Select the **Sample Once** button. Click the **Start** button and observe the results.

If problems occurred during the move an Alarm indicating a Fault or Warning may be displayed and need to be cleared. The drive may be left disabled until the Alarm is cleared and the Enable button is clicked.

Note: Clicking the Alarm Reset button and then the Enable button will clear a fault and enable the drive.

Now the motion parameters will need to be adjusted to achieve the desired move profile. The move can be repeated by clicking the **Start** button. If the drive continues to fault it is possible the maximum current or position error parameters are being exceeded. These can be set in the **Drive Configuration** tab.

The current setting can be checked by selecting **Current** in one of the Plot lists and clicking **Start** again to see what current is being required of the drive during a move. The current profile of the move will be displayed and may give a clue as to why a fault is occurring.

5.5.3 Adjusting tuning parameters

The two primary parameters for a Timed move are the **Proportional** (VP) & **Integral** (VI) gain parameters of the velocity loop.

Starting with these two terms is a good way to begin tuning as they are the minimum required terms in Velocity Loop tuning. The **FF Gain** is not required but adds to the tuning, this will be discussed later.

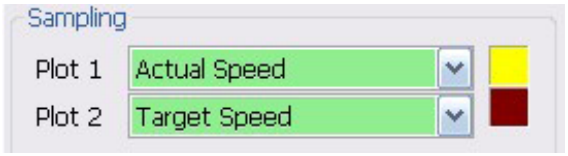
Note 1: The **Disable** button in the Menu bar of the SSM Quick Tuner window under the label **Servo** will disable the motor should a serious problem occur.

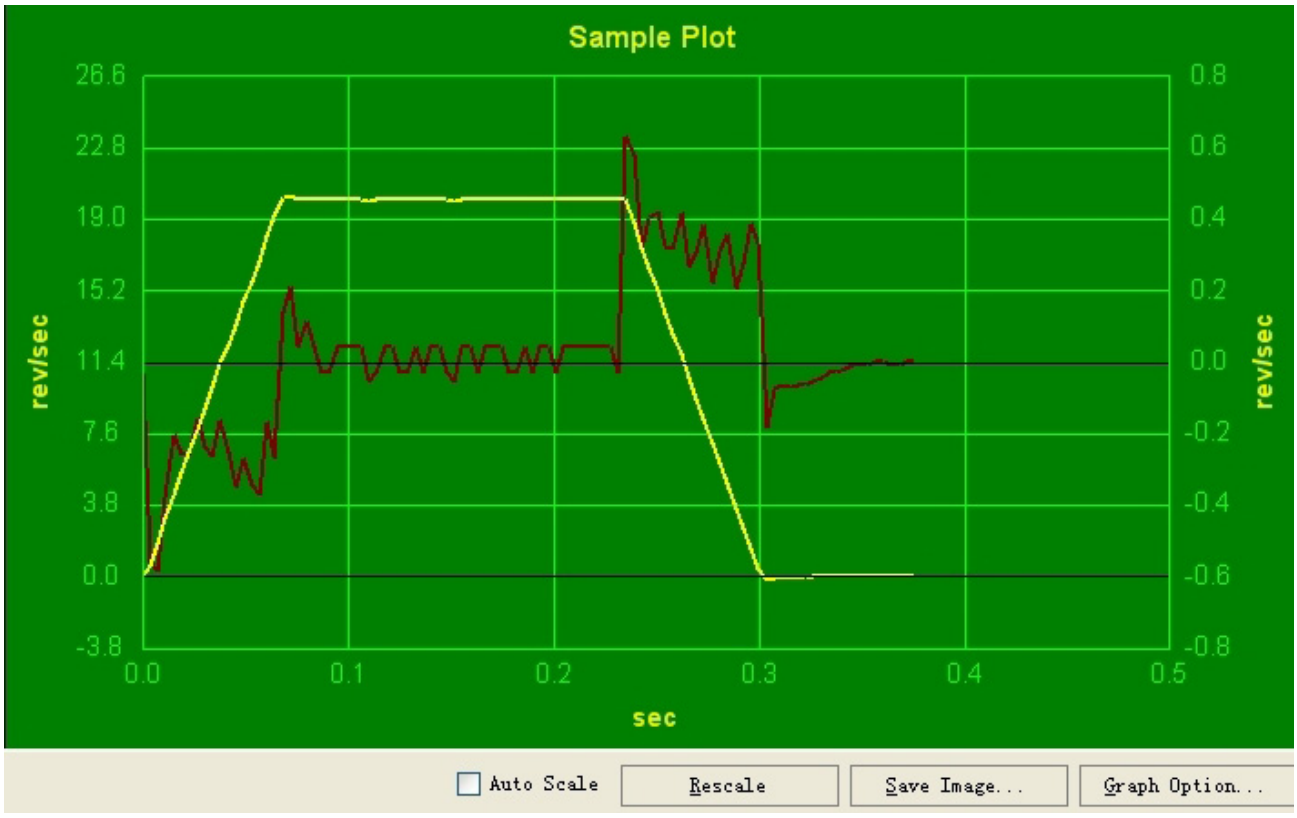
Note 2: The Gain values can be changed at any time during the tuning process. When the SSM Quick Tuner software detects a change in the value it will automatically download the new value. The **Download** button in the upper right of the window does not need to be clicked.

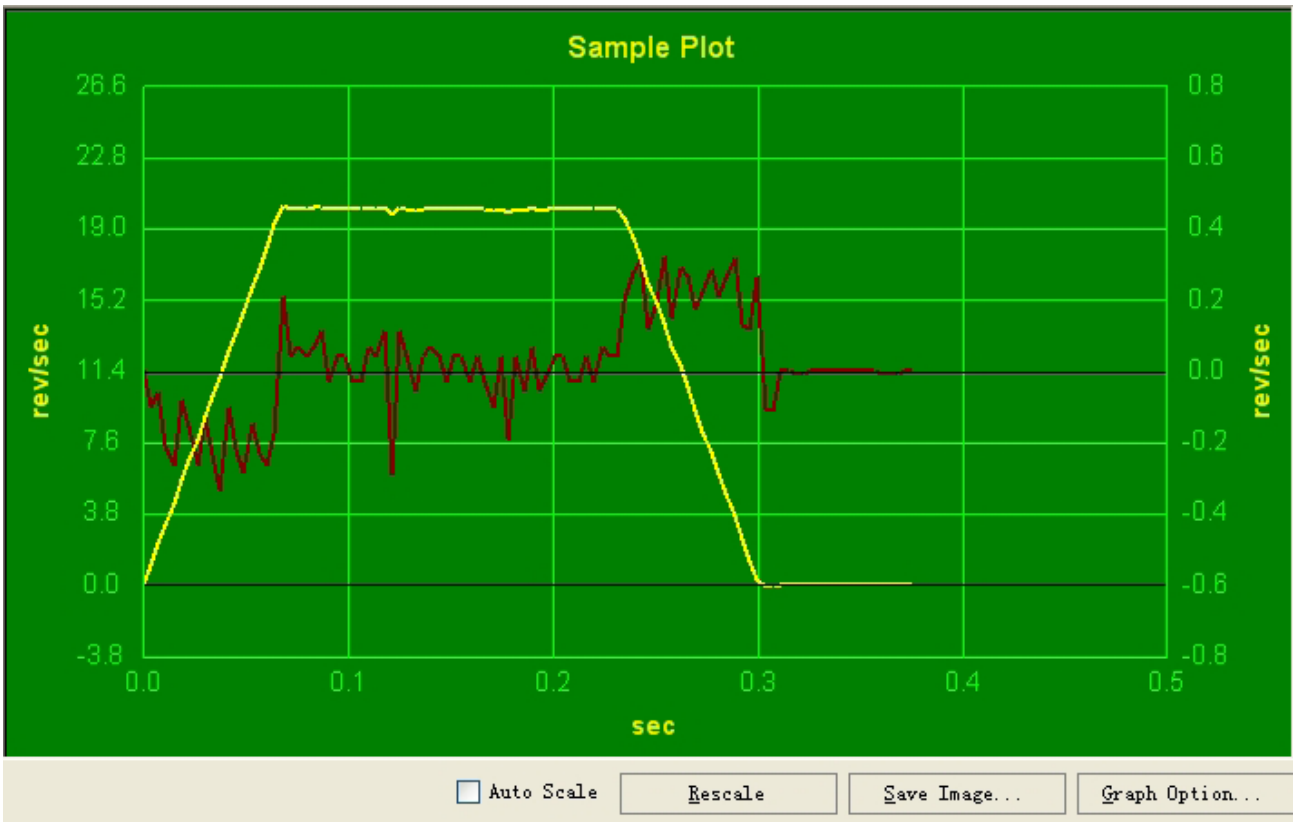
Once a successful move has been accomplished (no fault occurs) the motor is ready for tuning. Adjust the VP and VI parameters and observe the results. VP and VI shold be adjusted at the same time and in small increments. The following two figures shows responses with different VP and VI settings.

This first plot is performed with the default tuning values and no load added to the motor.

The second plot is performed with higher gain values for the VP (25000) and VI (3000), as can be seen the velocity error decreases as the gains are increased.





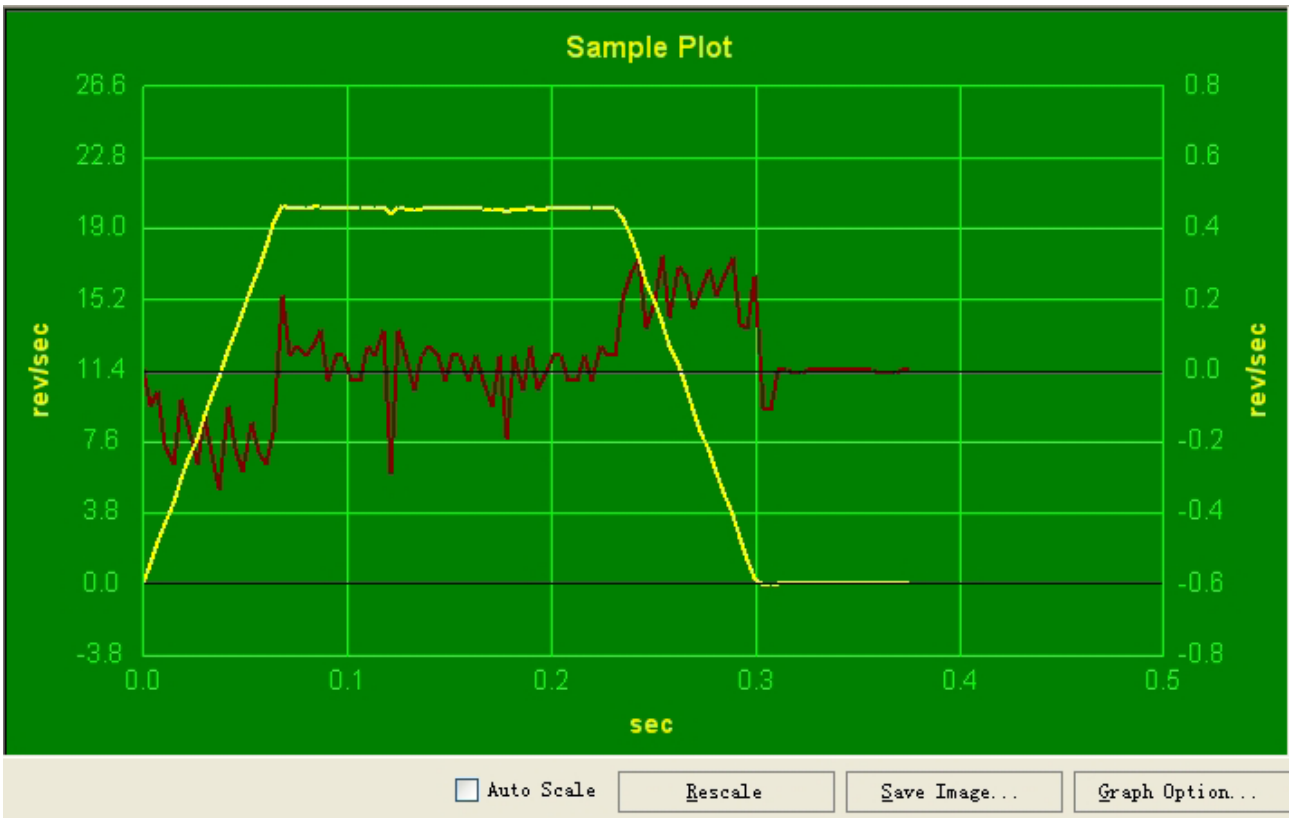


To get a good comparison between different plots where the gains have been changed, turn off the **Auto Scale** by clearing that check box below the plot screen. When auto scaling is turned off, the difference can be seen more clearly.

5.5.4 Adding in the FF Gain (KK) parameter

The Acceleration Feed Forward (KK) applies more current to the motor to help compensate for high inertia in the system. In a servo system more current is typically required during the acceleration and deceleration phases of the move profile.

A reduction in the Velocity Error peak values should then be seen. As seen in this plot with the KK set to 3000 the peaks in the Velocity error have been reduced. With loads that have greater inertia this can provide a significant improvement.



NOTE: The FF Term (KK) is not available when operating in the Pulse & Direction Control Mode. Setting this value will have no effect.

If the Velocity Error goes too positive during acceleration, the adjustment was too large and the value should be adjusted in smaller amounts until there is as near to zero error as possible. The **Rescale** button next to the **Auto Scale** may be clicked at any time to re-scale the plot on the new Velocity Error value.

5.5.5 Filter parameter

Step-servo has a control loop filter for special situations where the motor may resonate or may have significant audible noise. This filter is designed as a low pass type for the control loop output. When a system is subject to mechanical resonance, this low pass filter can be set below the natural frequency of the system so that the control loop output does not excite the resonance.

With a large inertial load, the gain parameters, especially the VP and VI terms, may need to be set high to get a good response. The filter may then need to be decreased in value (lower frequency) to prevent ringing or oscillation. The default of 15000 works well in many cases but can be increased or decreased with little risk.

5.5.6 Verify the Drive Current

The amount of drive current can be verified at any time during the tuning process to make sure the current supplied to the motor is not being limited by the drive. If too much current is being required changes may be made to the move profile. Select **Current** in one of the **Plot** selection lists and repeat the move, from this the current can be evaluated.

5.5.7 Finishing up

If the SSM will only be operated in a **Velocity Control Mode** with a **Speed only** Control Type, the tuning is complete. The Position Loop **(P Loop)** does not need to be tuned as it is not used. After verifying the drive current, the **Notch Filter** may be the only setting still needing adjusting. See section 5.8 on “Setting the Notch Filter”.

If the SSM will be operated in a **Position Control Mode,** proceed to section 5.6 ”Tuning the Position Loop” below.

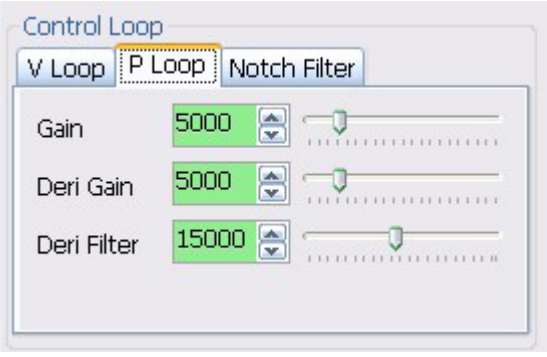
See Section 5.7 below on “Using Auto Trigger Sampling” for tuning the SSM while using an external Pulse & Direction controller.

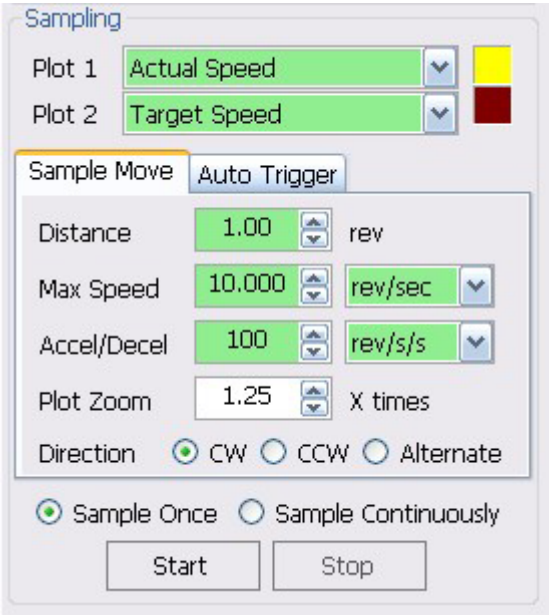
5.6 Tuning the Position loop

5.6.1 Entering a Sample Move

Select the **P Loop** tab in the **Control Loop** dialog section. This will cause the **Sampling** to do moves that are based on distance and operates the drive in the **Point to Point** Positioning mode.

Now the parameters for a **Position** based move can be entered. There is one consideration that must be addressed here. If the SSM is being operated in the **Position Control Mode** with a **Pulse & Direction Digital Signal Type** setting and being commanded by, for example, an external Pulse and Direction controller, the **Auto Trigger** option may be used to capture and plot the move. See Section 5.6 on “Using the Auto Trigger Sampling” for more details on this feature.





Plot 1 & Plot 2: two different values can be selected for viewing in the scope window, in this case **Actual Speed** and **Position Error** are selected. For Position tuning these are typical values.

Sample Move: move profile values are entered in the **Sampling** section. This example sets a move **Distance** of 3.00 revs at a **Max Speed** of 20,000 rev/sec and an **Accel/Decel** rate of 300 rev/s/s. In the window to the right of the **Sampling** data entry section the **Desired Profile** will be displayed. This provides a visual reference of what the expected move will look like.

Plot Zoom: the length of the plot values that are displayed can be set from 1 to 5 times the profile length.

Dir: the direction of the move can be set to **cw**, **ccw** or **alternate**. These directions refer to the motor shaft as viewed from the front of the motor. **Alternate** toggles the direction after each move. Start with a known direction before switching to toggle.

Sample Once: after the **Start** button is clicked, a single move is performed, the motor stops, and the results will be displayed.

Sample Continuously: after the **Start** button is clicked, the move will be repeated and the results displayed until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This enables more dynamic adjustment of the gains for speeding up the tuning process.

5.6.2 Performing a Move

Once the move settings are correct the mechanism to be moved shold also be checked to ensure it is ready to move. It is especially important to make sure the direction is set correctly. In some cases it is wise to select **alternate** to avoid running the mechanism into a hard stop. Select the **Sample Once** button. Click the **Start** button and observe the results.

If problems occurred during the move an Alarm indicating a Fault or Warning may be displayed and need to be cleared. The drive may be left disabled until the Alarm is cleared and the Enable button is clicked.

Note: Clicking the Alarm Reset button and then the Enable button will clear a fault and enable the drive.

Now the motion parameters will need to be adjusted to achieve the desired move profile. The move can be repeated by clicking the **Start** button. If the drive continues to fault it is possible the maximum current or position error parameters are being exceeded. These can be set in the **Drive Configuration** tab.

The current setting can be checked by selecting **Current** in one of the Plot lists and clicking **Start** again to see what current is being required of the drive during a move. The current profile of the move will be displayed and may give a clue as to why a fault is occurring.

5.6.3 Adjusting the Gain (KP) and Deri Gain (KD) parameters

Adjust the KP and KD parameters and observe the results. Increasing the KP may improve the positioning performance, but it may also cause the system to be more unstable. To counter this the KD can be increased. The KD parameter is important: too little gain will cause the system to oscillate; too much gain may cause the system to squeal from a high frequency oscillation. If a very springy coupler is used between the motor and load, the KD parameter may need to be reduced until the system is stable or the **Notch Filter** may need to be used to reduce the system gain at the sensitive frequency where it oscillates.

5.6.4 The Deri Filter (KE) parameter

With a large inertial load, the KP and KD gain parameters may need to be set high to get good response. The filter may then need to be decreased in value (lower frequency) to prevent ringing or decrease the derivative noise.

5.6.5 Filter parameter (again)

Sometimes it may also be necessary to adjust the output filter when gain values increase. The filter frequency may then need to be decreased in value to prevent ringing or oscillation.

5.6.6 Verify the Drive Current

The amount of drive current can be verified at any time during the tuning process to make sure the current supplied to the motor is not being limited by the drive. If too much current is being required changes may be made to the move profile. Select **Current** in one of the **Plot** selection lists and repeat the move, from this the current can be evaluated.

5.6.7 Finishing up

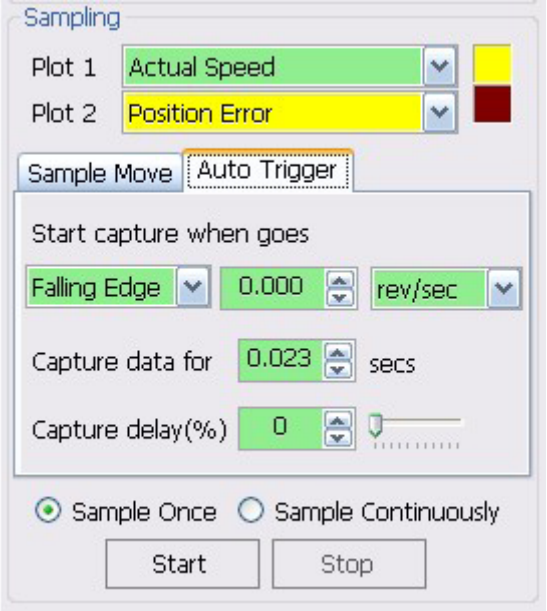
After verifying the drive current, the **Notch Filter** may be the only setting still needing adjusting. See section 5.8 on “Setting the Notch Filter”.

5.7 Using Auto Trigger Sampling

In cases where an external controller is used to perform move profiles, such as in the **Position Control Mode** using **Pulse & Direction** input, the **Auto Trigger** will allow the **Sampling** to collect data and display the move profile.

This sampling technique is different in that it is not triggered by the start of a move profile as the drive cannot know when the move is actually started (remember the controller is external). Instead the **Auto Trigger** waits for a predefined set of conditions to tell it when to start collecting the move profile data.

5.7.1 Setting up Auto Trigger

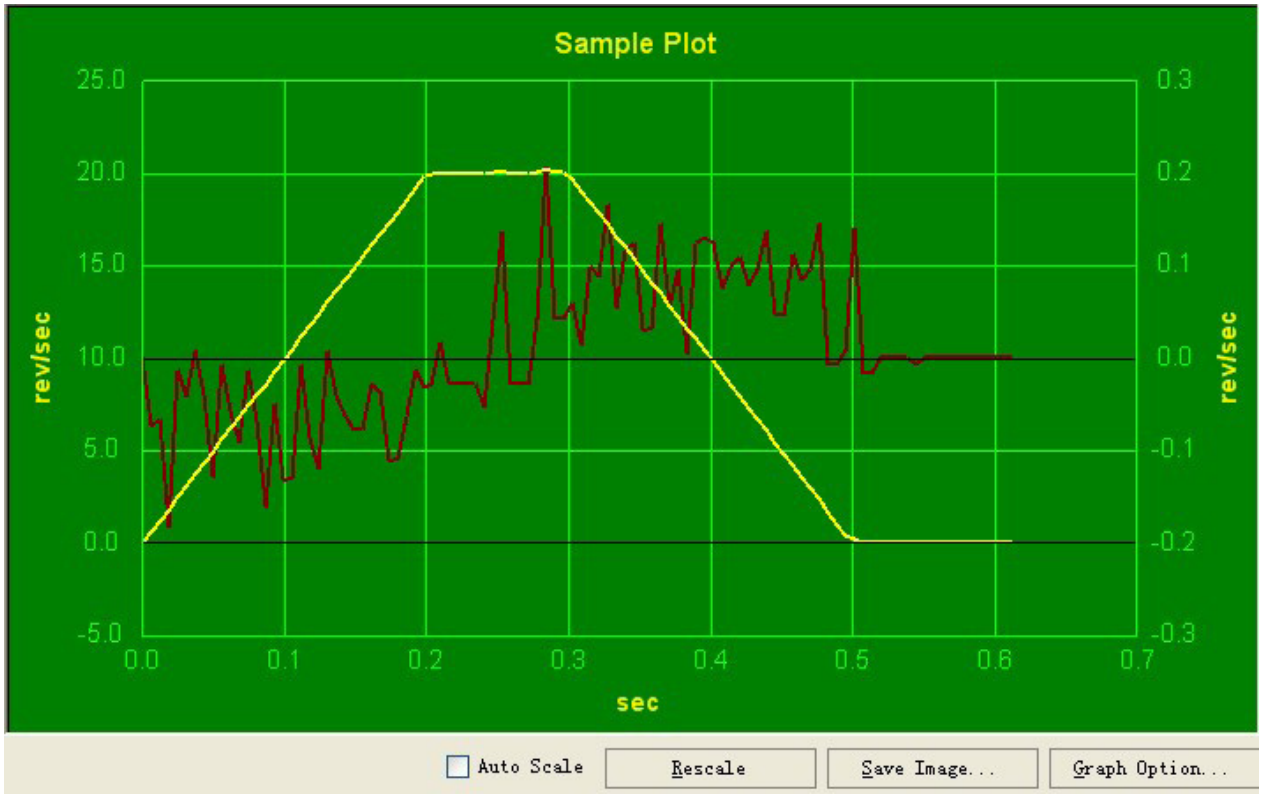


When using **Auto Trigger**, the primary effort is to select the conditions that will trigger the sampling. Begin by selecting the desired trigger value in the **Plot 1** list. This selection is what is monitored by the Auto Trigger, **Plot 2** is not monitored.

In the Auto Trigger tab the displayed text will indicate the value to be used and the conditions to trigger the capture of the selected value. In the example to the right, the capture will begin when **Actual Speed** is **Above 1.000 rev/sec**, the capture will **Capture data** for **0.300 seconds** and there will be a **10% Capture delay** from the beginning of the capture to the trigger point. The **Capture delay** allows viewing of the data prior to the trigger point so that a more complete profile can be observed.

When changing **Plot 1** to other selections notice that the conditions for the capture trigger will change with it. For example, when selecting **Position Error** the capture will look at **Counts** for determining the trigger point.

Sample Once: when the **Start** button is clicked the SSM drive begins continuous collection of data. It will constantly check the data to see if the value meets the capture trigger conditions. At the same time Quick Tuner monitors the status of the SSM to detect if the capture is complete. When the capture is complete the data is displayed in the profile window.



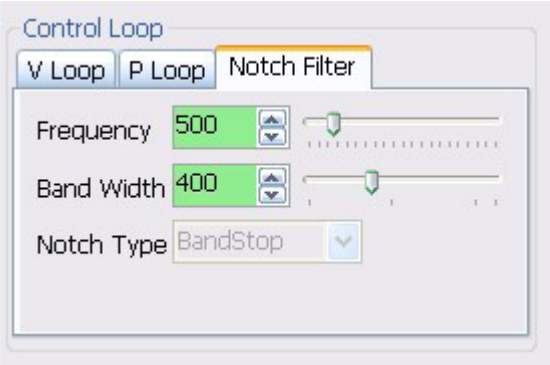
Sample Continuously: when the **Start** button is clicked the capture is repeated each time the trigger condition is met until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This allows more dynamic adjustment of the gains for speeding up the tuning process

NOTE: When adjusting control loop gain values remember that the FF Term (KK) has no effect when operating in the Position – Pulse & Direction Control Mode.

5.8 Setting the Notch filter

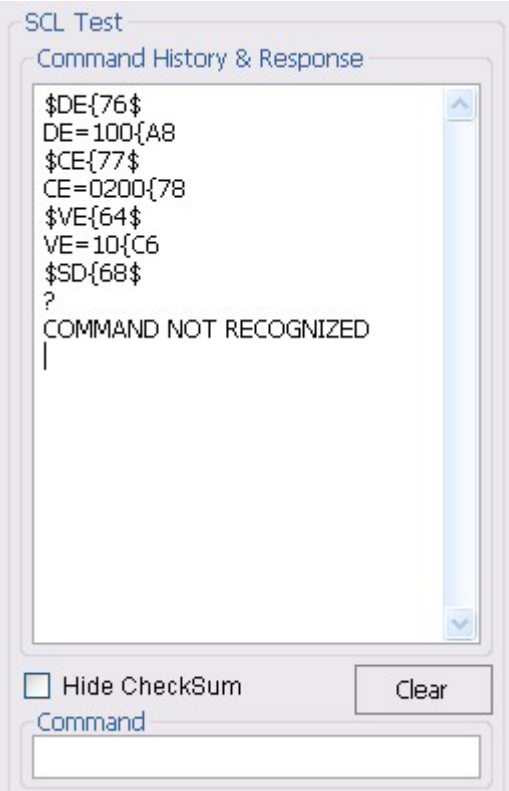
The notch filter is used when there is a specific resonate frequency present in the system and good performance requires that only the “bad” frequency be removed. Sometimes the resonate frequency is low enough that it should only be removed using the notch filter. Using the standard output filter or reducing the gain settings may compromise the system performance too much.

When performing the move profiles as discussed above, a significant resonate frequency may be experienced visually on the plot window, audibly, or both. Finding this frequency can be a difficult task and it is often discovered by experimentation. Change the frequency then perform sampling moves until the resonance is reduced or removed. Keeping the bandwidth wide (maybe equal to the center frequency) may help find the center frequency. When the center is found, the bandwidth may be reduced until the resonance starts to return.



6 SCL Test & Monitor

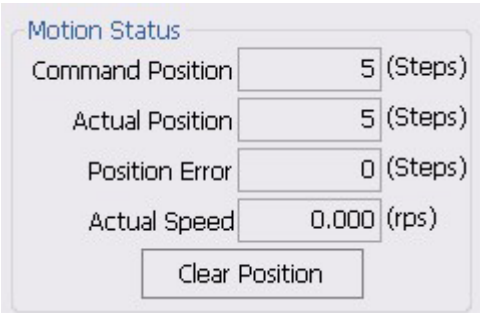
6.1 SCL Test



The **SCL** (Serial Command Language) **Test** tool is used to send commands to the serial port of the connected drive. A command can be entered manually in the **Command** window at the bottom of the screen. The history of the sent command and responses of the drive are displayed in the **Command History & Response** window. This tool is designed to help the user learn SCL usage prior to implementation on the system controller. The command interface allows entry of all supported SCL commands. Any command syntax errors that are encountered are also displayed in the response window. The Command History & Response window also displays commands and responses used when operating the other functions provided on the SCL Test & Monitor tab such as Jog Move or Single Move.

SSM Quick Tuner communicates to the connected drive using a high baud rate of 115200 and a protocol that includes the Checksum. These protocol settings are used to provide high speed and reliable communications with the drive during the configuration, tuning, or testing operations. The response window will indicate the exact command syntax that is being used. This means that the user will be able to see both the Checksum calculated for that command and the Checksum provided in the response by the drive. This is a useful feature to help the system programmer determine the proper Checksum calculation in the system controller. An option that is not recommended is to check the **Hide Checksum** box (turns off the Checksum). A user might also select hiding the Checksum so that it is not visible in the Command History & Response window.

6.2 Motion Status

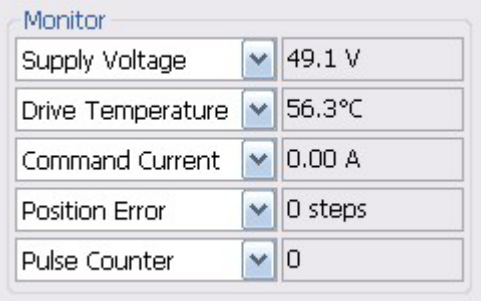


The **Motion Status** tool provides the most common information needed about the moving or position status of the drive. Four parameters are displayed that will show the **Command Position**, **Actual Position**, **Position Error** and the **Actual Speed**. Although the drive is being constantly polled for this status information, the information is not real time as there is a slight delay in the polling routine.

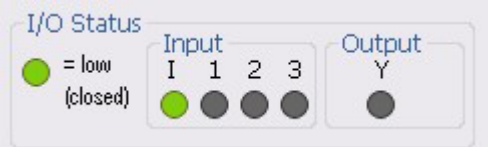
The **Clear Position** button is provided to clear the position information and set it to zero. The position can only be cleared when the motor is not moving.

6.3 Monitor

The **Monitor** tool allows the user to view five of nine different parameters at any one time. Each of the 5 dropdown lists contains the same 9 parameters that can be selected and displayed. These parameters are updated as part of the polling process and therefore the values may lag behind the actual value in the SSM.



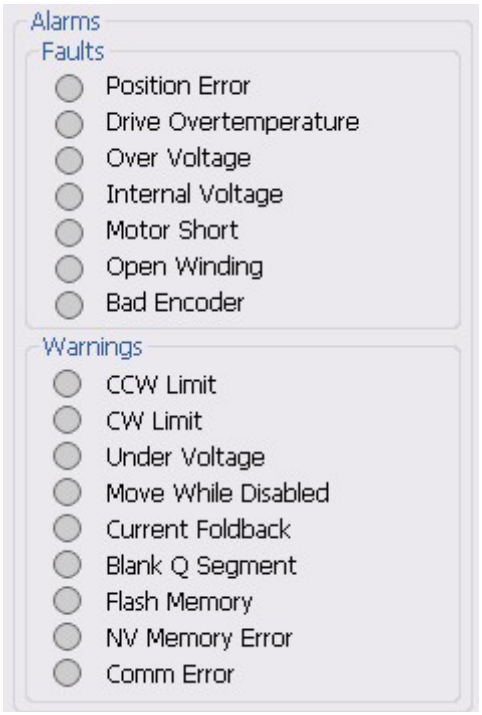
6.4 I/O Status



The **I/O Status** tool displays the current state of the three **Inputs (1, 2, 3)** the one **Output** (Y) and the Encoder Index sensor (I) if there is one. When the I/O indicator is gray this shows an “open” condition. For the Inputs, this means the circuit is not activated and will be “high”; for the Output this means it is off and also “high”. When the indicator is green the Input has been activated and is considered “low”; the same is true for the Output. The Encoder Index also follows this convention.

6.5 Alarm

The SSM has a number of different **Alarm** indications that will give either fault or warning conditions of the drive. Alarms are shown in the 2 different categories of **Faults** or **Warnings** because of the difference in how they affect the drive status. Alarm faults indicate that a serious condition has occurred, the drive has been shut down, and is in a disabled state. Warnings are informational and may or may not be serious. The operational conditions must be considered when warning occurs. Warnings do not disable the drive but the CW or CCW limits will halt the movement of the motor.

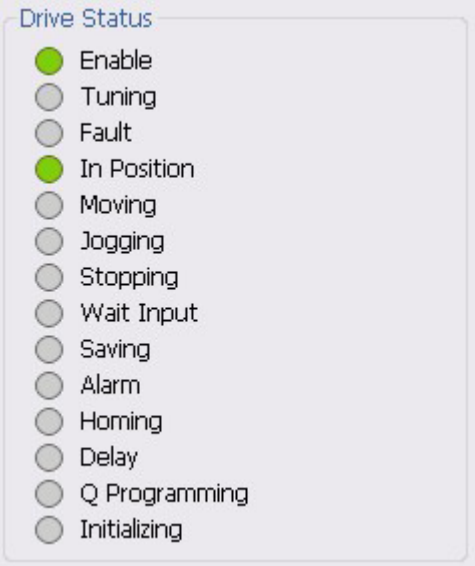


When fault conditions occur the user must take care to evaluate the condition and may need to remedy the cause. Faults or Warnings may be cleared using the **Alarm Reset** button at the top of the application window. If a Fault or Warning is not cleared after clicking this button the condition which caused the Alarm may still be present. When clearing a Fault the drive is not automatically re-enabled, the **Enable** button must also be clicked to re-enable the drive.

Faults	
Position Error	the drive exceeded the position fault limit as set by the PF (Position Fault) command
Drive Overtemperature	the DSP temperature exceeded 95 C or the drive internal PCB exceeded 85℃
Over Voltage	the DC bus voltage exceeded 75 VDC
Internal Voltage	one of the internal power supplies exceeded its range limit
Motor Short	a motor phase experienced a short circuit condition
Open Winding	a motor phase winding was open at power up
Bad Encoder	(not implemented at this time)
Warnings	
CCW Limit	when the DL (Define Limits) command is configured, Input#2 has been triggered
CW Limit	when the DL (Define Limits) command is configured, Input#1 has been triggered
Under Voltage	the DC bus voltage has dropped below 10 VDC
Move While Disabled	a move was commanded while the drive was disabled
Current Foldback	the command current exceeded either the boost or continuous limit
Blank Q Segment	does not apply to an S model
Flash memory	a flash memory error occured when saving parameters
NV Memory Error	the flash memory was found corrupted at power-up
Comm Error	the drive has detected a communications error either in the hardware or in the protocol

6.6 Drive Status

The **Drive Status** is an overall indication of the drive condition. In a typical application this is the most common information that should be collected from the drive. Collecting the drive status information allows the system controller to keep track of drive operations and conditions.

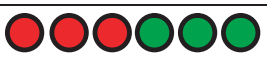


Drive Status	
Enabled	the drive is enabled and ready for moving operations
Tuning	the drive is in the process of tuning data capture
Fault	an alarm fault condition has occured (check Alarm Status)
InPosition	command position is within the PL (Position Limit) range
Moving	a commanded move is in process
Jogging	commanded jogging is in process
Stopping	the motor is decelerating
WaitInput	a WI (Wait on Input) command is executing
Saving	drive is saving parameter data
Alarm	an Alarm Code is present
Homing	the SH (Seek Home) command is executing
Delay	a WT (Wait Time) command is executing
Q Programing	does not apply to an S model
Initializing	the drive is in the process of power-up initialization

7 Troubleshooting

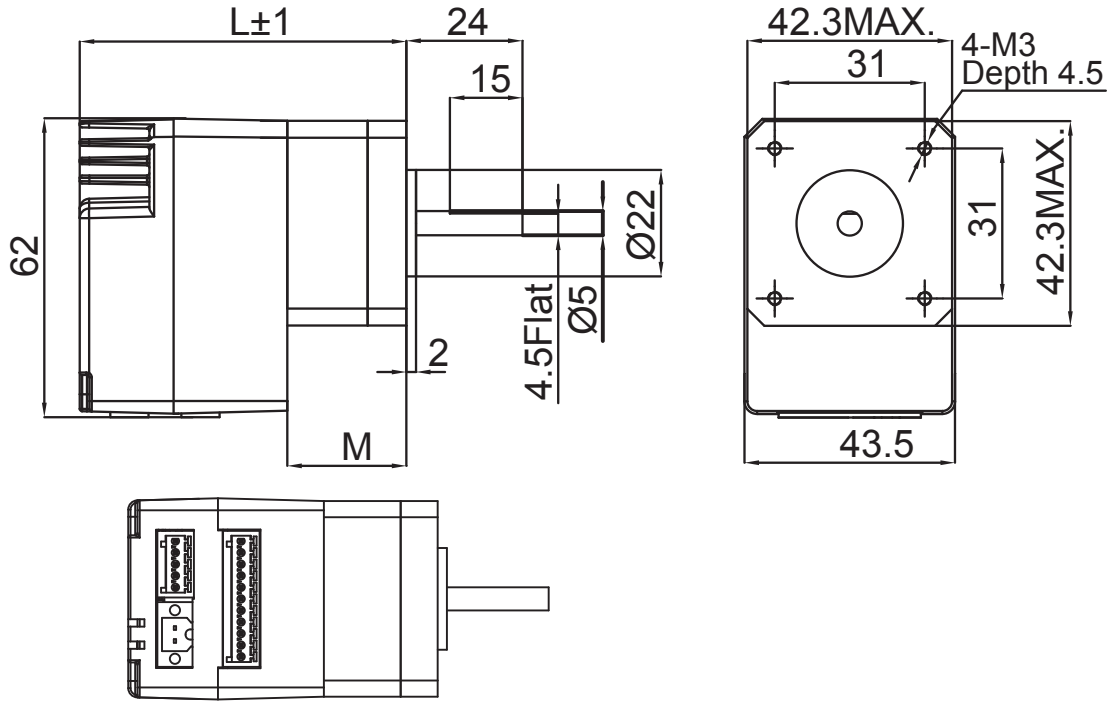
LED Error Codes

The SSM17C uses red and green LEDs to indicate status. When the motor is enabled, the green LED flashes slowly. When the green LED is solid, the motor is disabled. Errors are indicated by combinations of red and green flashes as shown below. This feature can be disabled for certain warnings but not for alarms. See section 4.1.4 on “LED Flashing” above for information on how to do this and which warnings may be masked.

	Code	Error
	solid green	motor disabled
	flashing green	motor enabled
	1 red, 1 green	position limit
	1 red, 2 green	drive disabled
	2 red, 1 green	ccw limit
	2 red, 2 green	cw limit
	3 red, 1 green	over temperature
	3 red, 2 green	internal voltage
	3 red, 3 green	non-volatile memory error
	4 red, 1 green	over voltage
	4 red, 2 green	under voltage
	4 red, 3 green	non-volatile double error
	5 red, 1 green	over current
	5 red, 2 green	current limit
	6 red, 1 green	open winding
	6 red, 2 green	encoder failure
	7 red, 1 green	communication error
	7 red, 2 green	save failed

8 Reference Materials

8.1 Mechanical Outlines



Unit:mm

Model	Length (L)	Length (M)
SSM17C-1□G	67.5	24.6
SSM17C-2□G	73	30.1
SSM17C-3□G	81.5	36.6

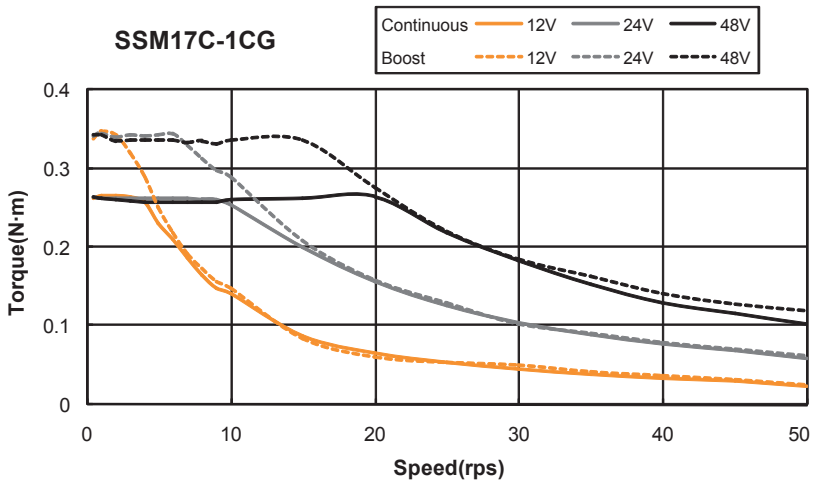
8.2 Technical Specifications

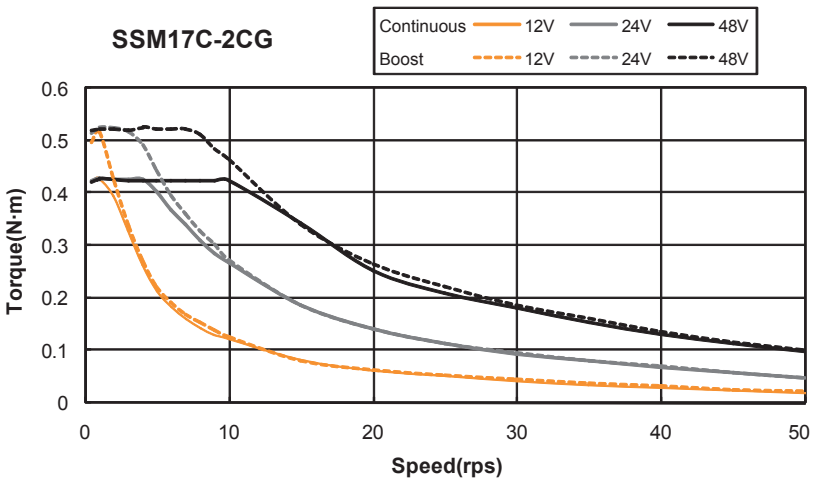
Power Amplifier	
Amplifier Type	Dual H-Bridge, 4 Quadrant
Current Control	4 state PWM at 20 KHz
Output Torque	SSM17C-1CG: Up to 0.28N•m Continuous(0.35 N•m Boost) SSM17C-2CG: Up to 0.42N•m Continuous(0.52 N•m Boost) SSM17C-3CG: Up to 0.52N•m Continuous(0.68 N•m Boost)
Power Supply	External 12 - 48 VDC power supply required
Protection	Over-voltage, under-voltage, over-temp, motor/wiring shorts (phase-to-phase, phase-to-ground)
Controller	
Electronic Gearing	Software selectable from 200 to 51200 steps/rev in increments of 2 steps/rev
Encoder Resolution	20000 counts/rev
Speed Range	Up to 4800rpm
Filters	Digital input noise filter, Analog input noise filter, Smoothing filter, PID filter, Notch filter
Non-Volatile Storage	Configurations are saved in FLASH memory on-board the DSP
Modes of Operation	CANopen slave node plus stored Q Program execution
Digital Inputs	Digital Inputs Adjustable bandwidth digital noise rejection filter on all inputs **IN1+/-** : Optically isolated, 5-24 volt. Minimum pulse width = 250 ns, Maximum pulse frequency = 2 MHz Function: CW limit, CW jog, or general purpose input **IN2+/-** : Optically isolated, 5-24 volt. Minimum pulse width = 250 ns, Maximum pulse frequency = 2 MHz Function: CCW limit, CCW jog, or general purpose input **IN3+/-** : Optically isolated, 5-24 volt. Minimum pulse width = 100 µs, Maximum pulse frequeny = 10 KHz Function: general purpose input
Digital Output	**OUT+/-**: Optically isolated, 30V/100 mA max. Function: Fault, motion, tach, in position, brake, or general purpose programmable
Analog Input	AIN referenced to GND. Range = 0 to 5 VDC. Resolution = 12 bits
Communication Interface	CANopen, RS-232
Physical	
Ambilent Temperature	0 to 40°C (32 to 104°F) When mounted to a suitable heatsink
Humdity	90% Max., non-condensing
Mass	SSM17C-1CG: 280 g SSM17C-2CG: 360 g SSM17C-3CG: 440 g
Rotor Inertia	SSM17C-2CG: 38 g•cm^2 SSM17C-2CG: 57 g•cm^2 SSM17C-3CG: 82 g•cm^2

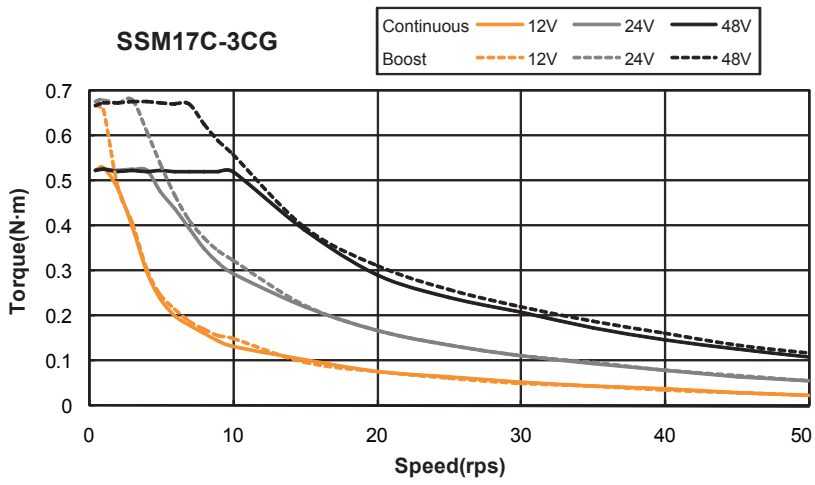
8.3 Torque-Speed Curves

Note: all torque curves were measured at 20,000 steps/rev.

Note: 2 amp rating is continuous,3 amp rating is boost







8.4 SCL Command Reference

The Serial Command Language (SCL) was developed to give users a simple way to control a motor drive via a serial port. This eliminates the need for separate motion controllers or indexers to supply Pulse and Direction signals to the drive. It also provides an easy way to interface to a variety of other industrial devices such as PLCs and HMIs, which often have standard or optional serial ports for communicating to other devices. Some examples of typical host devices might be:

- A Windows based PC running MOONS' software
- An industrial PC running a custom or other proprietary software application
- A PLC with an ASCII module/serial port for sending text strings
- An HMI with a serial connection for sending text strings

SCL commands control the motion of the step motor, use of the inputs and outputs, and configure aspects of the drive such as motor current and microstep resolution.

In SCL mode, the SSM17C receives commands from the host, executing them immediately or sending them to a command buffer and then executing them directly from the buffer. It cannot, however, create a stored program for stand-alone operation. For that function, the SSM17Q is needed.

The communications protocol of SCL is simple in that the host initiates all communication, with one exception. The only time the drive will initiate communication is at power-up. At that time, the drive will send an identifier to tell the software which drive is connected and what the firmware version is.

There are two types of SCL commands: buffered and immediate. Buffered commands are loaded into and then executed out of the drive's command buffer. Buffered commands are executed one at a time and in sequential order. The buffer can be filled with commands without the host controller needing to wait for a specific command to execute before sending the next command. Special buffer commands enable the buffer to be loaded and to pause for a desired time.

Immediate commands are not buffered, but are executed immediately, running in parallel with a buffered command if necessary. Immediate commands are designed to access the drive at any time and can be sent as often as needed. This allows a host controller to get information from the drive at a high rate, most often for checking drive status or motor position.

The basic structure of a command packet from the host to the drive is always a text string followed by a carriage return. The text string is composed of the command itself, followed by any required parameters. A carriage return denotes the end of transmission to the drive.

The syntax of the command is

XXAB<cr>

where **XX** designates the command (always composed of 2 uppercase letters), and **A** and **B** define the possible parameters. These parameters can vary in length, can be letters or numbers, and are often optional. Once a drive receives the **<cr>** (carriage return), it will determine whether or not it understood the command-if it did, it will either execute or buffer the command. The drive can also be programmed ahead of time to send a response as to whether or not it understood the command as well as any error code.

Some SCL commands transfer data to the drive for immediate or later use. These data values are stored in data registers and remain there until new commands change the values or power is removed from the drive. Some data registers in a drive are Read-Only and contain predefined information about the drive which can also be read through SCL commands.

Because of the intense nature of serial communications required in host mode applications, there is a serial communication Protocol (PR) command available that will adjust a drive's serial communications protocol to best fit an application. Typically this command is used when configuring a drive and saved as part of the startup parameters. But it can be used at any time to dynamically alter the serial communications.

The SCL Utility Software Manual contains the complete command listing as well as instructions on connecting and configuring the SSM17C for use in SCL mode, using the Data Registers and the Protocol command. It also contains detailed information on:

- Host Serial Communications
- Host Serial Connections
- Alarm and Status Codes
- Working with Inputs and Outputs

The Manual is available from the MOONS' website at http://www.moonsindustries.com/Products/Drives/Software/.

under the SCL Utility download section.

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